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ANNUAL REPORT

OF THE

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CAMBRIDGE, MASS.

Being for the Year 1897.

IN THREE PARTS.

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PART II.—REPORT ON SALMON FISHERIES.

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SIXTEENTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

LORD BALFOUR OF BURLEIGH,

Her Majesty's Secretary for Scotland.

OFFICE OF FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 1*st April* 1898.

MY LORD,

In continuation of our Sixteenth Annual Report, we have the honour to submit—

PART II.—REPORT ON SALMON FISHERIES.

The fishing season of 1897 appears, from all available sources of information, to have been below the average. The number of boxes of salmon sent to Billingsgate was 30 per cent. less than the average of the previous sixty-three years, and nearly 26 per cent. under the average of the previous ten years. In the following Table will be found the numbers sent in each year since 1834 —each box weighing about 1 cwt. :—

Table of Boxes of Scottish Salmon sent to Billingsgate from 1834 to 1897 inclusive.

Year.	Boxes of Salmon.	Year.	Boxes of Salmon.
1834	30,650	1866	21,725
1835	42,330	1867	23,006
1836	24,570	1868	28,020
1837	32,300	1869	20,474
1838	21,400	1870	20,648
1839	16,340	1871	23,390
1840	15,160	1872	24,404
1841	28,500	1873	30,181
1842	39,417	1874	32,180
1843	30,300	1875	20,375
1844	28,178	1876	34,655
1845	31,062	1877	28,189
1846	25,510	1878	26,465
1847	20,112	1879	13,929
1848	22,525	1880	17,457
1849	23,690	1881	23,905
1850	13,940	1882	22,968
1851	11,593	1883	35,506
1852	13,044	1884	27,219
1853	19,485	1885	30,362
1854	23,194	1886	23,407
1855	18,197	1887	26,907
1856	15,438	1888	22,857
1857	18,654	1889	21,101
1858	21,564	1890	18,931
1859	15,823	1891	25,889
1860	15,870	1892	21,919
1861	12,337	1893	18,903
1862	22,796	1894	15,489
1863	24,297	1895	25,364
1864	22,603	1896	22,435
1865	19,009	1897	16,284

The monthly return of the number of boxes of Scottish salmon received at Billingsgate, which, as heretofore, has been kindly furnished by the Fishmongers' Company, shows that the decrease was most marked in the last three months of the season, that the quantity received in March and April was 30 per cent. below the average of the corresponding months in the years 1884-93, and that the only month in which the quantity reached the corresponding monthly average of the years 1884-93 was the month of May. In the following Table will be found the number of boxes received at Billingsgate monthly, from February to December inclusive, during the years 1894 to 1897 inclusive, the average number of boxes received in each month in the years 1884-93, and the average monthly price per lb. in the years 1893-96, and the average price per lb. obtained in each month during 1897:—

[TABLE.

Table of Boxes of Scottish Salmon sent to Billingsgate in each month.

Month.	Average of 10 years, 1884-93.	1894.	1895.	1896.	1897.	Average monthly price per lb. during 1893-96.		Average monthly price per lb. during 1897.	
						s.	d.	s.	d.
February, . .	*818*	327	400	822	773	1	9¼	2	0½
March, . .	*1,071*	692	1,207	1,385	724	1	8½	2	5½
April, . . .	*1,416*	887	1,160	1,580	1,038	1	9½	2	2½
May, . . .	*2,335*	1,745	2,567	2,376	2,311	1	8	1	6
June, . . .	*3,540*	3,078	4,611	3,595	3,127	1	4¾	1	4½
July, . . .	*7,949*	4,464	9,066	7,450	5,081	0	11¼	1	4
August, . .	*6,094*	3,968	5,694	4,477	3,001	1	1	1	5
September, . .	*526*	328	659	750	213	1	10	2	0
Do., . .	...	...	...	...	*6	...		*1	7
October, . .	...	...	...	...	*9	...		*1	7
November, . .	...	...	...	...	...	...		...	
December, . .	...	...	...	...	*1	...		...	
Total, .	*23,749*	15,489	25,364	22,435	16,284				

* Frozen salmon.

The value of the salmon sent from Scotland to Billingsgate during 1897 compares favourably with the returns of former years. If it is assumed that each box contains 1 cwt. of salmon, the value of the salmon delivered there in 1897 would amount to £139,405 9s. 4d., or, on an average, £8 11s. 2½d. per cwt., whereas the average annual value in the years 1893-96 inclusive was £137,915 11s. 2d., or £6 14s. 11½d. per cwt. Thus, although the number of boxes delivered at Billingsgate during 1897 was 4,264 less than the average number delivered annually in the period 1893-96, there was an increase of £1,489 18s. 2d. in their value.

Boxes of Scottish Salmon forwarded from various Stations, Ports, &c.

The returns furnished by the Scottish railway companies and steamship owners regarding the weight of the boxes of salmon forwarded by them in 1897 show that the quantity carried was 34 per cent. less than the average return for each of the three previous years for which similar information is available. The most marked decrease appears to have been in the district between Cape Wrath and Glasgow, where the weight of the boxes forwarded was 45 per cent. below the average; in each of the two districts between Berwick and Cape Wrath it was 33 per cent.; while from Glasgow to the Border it was 21 per cent. These returns have been embodied in the following Table:—

District.	1894.				1895.				1896.				1897.			
	Weight.				Weight.				Weight.				Weight.			
	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.
Berwick to Cairnbulg Point, . .	963	8	2	23	1,834	1	3	24	1,583	6	1	26	987	5	1	4
Cairnbulg Point to Cape Wrath,	729	2	3	17	1,492	12	..	7	987	13	1	8	717	4	..	7
Cape Wrath to Glasgow, . .	471	13	3	4	576	7	..	10	414	2	3	5	270	15	..	1
Glasgow to the Border, . . .	273	6	..	..	326	..	1	17	293	3	..	1	219	8	..	21
Total, . . .	2,437	11	1	16	4,229	1	2	2	3,278	5	2	12	2,194	12	2	5

Replies to Printed Queries regarding the yield of the Salmon Fishings in 1897.

p. 17.

The replies which have been received to the usual circular of printed queries issued at the close of the salmon fishing season indicate that the season of 1897 was below the average. These queries are sent to Clerks of District Boards with a view of ascertaining, as far as possible, the state of the salmon fisheries. The answers are given in Note I. of the Appendices to this Report. It will be observed that replies have been received regarding the following districts, viz.:—The Tay, South Esk, North Esk, Dee (Aberdeenshire), Don, Ythan, Ugie, Deveron, Spey, Findhorn, Ness, Alness, Conon, Kyle of Sutherland, rivers of Sutherlandshire, Lochy, Ayr, Girvan, Stinchar, Cree, Dee (Kirkcudbrightshire), Nith, and Annan, and that, except in the case of the Ness, the rivers of the north coast of Sutherlandshire, and the Ayr, all the reports are to the effect that the past season has been "below," or "much below," the average. About an average season is reported from the districts of the river Ness and of the rivers of the north coast of Sutherlandshire, while the only district in which the take of fish is reported as having been rather above the average is that of the river Ayr.

Rental of Tay Salmon Fishings.

The following is the rental of the Tay fishings since 1828:—

Year.	Rental.			Year.	Rental.		
1828	£14,574	10	0	1863	£14,232	16	6
1829	14,529	10	0	1864	16,742	5	2
1830	13,747	8	0	1865	17,618	0	7
1831	13,874	0	0	1866	17,465	3	4
1832	11,629	0	0	1867	16,852	18	4
1833	11,577	0	0	1868	16,965	15	10
1834	10,907	10	0	1869	17,444	15	0
1835	10,856	10	0	1870	17,044	8	4
1836	10,211	10	0	1871	16,382	8	4
1837	10,150	6	0	1872	15,162	15	0
1838	10,285	0	0	1873	17,519	14	0
1839	10,498	0	0	1874	18,941	13	8
1840	11,058	0	0	1875	21,634	4	4
1841	10,846	5	0	1876	19,930	18	4
1842	10,235	15	0	1877	21,126	14	0
1843	10,512	5	0	1878	21,187	1	0
1844	10,386	10	0	1879	21,697	14	0
1845	10,751	15	0	1880	22,518	8	7
1846	10,099	15	0	1881	19,579	11	5
1847	11,421	10	0	1882	19,221	11	7
1848	12,057	10	0	1883	17,773	3	0
1849	10,729	16	0	1884	19,655	14	5
1850	9,491	11	0	1885	20,417	0	2
1851	9,530	0	0	1886	22,542	2	8
1852	7,973	5	0	1887	22,143	16	7
1853	8,715	17	6	1888	19,655	0	0
1854	9,269	6	5	1889	17,731	2	0
1855	9,977	13	5	1890	17,819	10	0
1856	10,199	10	4	1891	17,237	6	8
1857	10,772	0	5	1892	19,018	0	0
1858	11,487	2	5	1893	21,762	14	3
1859	11,884	14	0	1894	19,578	7	5
1860	13,827	10	7	1895	17,090	15	4
1861	14,009	15	7	1896	17,180	17	9
1862	14,080	12	0	1897	17,869	3	4

Return of the Fish caught at the Salmon Fishings belonging to the Aberdeen Harbour Commissioners.

The Aberdeen Harbour Commissioners have kindly furnished a statement of the number and weight of fish caught at their salmon fishings on the river Dee and the sea coast adjoining since 1872. This return is given on page x., and shows that a scarcity of grilse was a marked feature in last year's fishing season. In one only of the twenty-six years for which statistics are available were fewer grilse caught. Salmon were more numerous than in eight previous years, although considerably below the average of recent years. The decrease in the total number of fish caught is also due, in a measure, to the comparatively small number of sea trout which were taken.

Salmon Disease.

With regard to salmon disease in 1897, it is reported from the Tay that the disease made its appearance, but that the number of fish affected cannot be stated; from the North Esk, that the number taken out of the river was 507, as against 175 in the previous year; from the Aberdeenshire Dee, that there was very little appearance of disease; from the Don, that 145 diseased fish were taken out of the river, being an increase of 107 on 1896; from the Ythan, that 61 fish succumbed, as against 467 in the previous year; and from the Deveron, that 243 fish died of the disease. In the Spey district the number of fish affected appears to have been below the average; while in the rivers of the east coast of Sutherlandshire, the Stinchar, the Nith, and the Annan, the disease is reported to have shown itself only to a very slight extent.

Inspections during 1897.

During 1897 Mr. Archer inspected the rivers North Esk, South Esk, Deveron, Kirtle, and Nith, the works erected by the Glasgow Waterworks Commissioners at the outlet of Loch Katrine, and the salmon fishings at Bonar Bridge on the Kyle of Sutherland. His general report to the Board is given on p. 5, and a special report on Craigo and Morphie dam dykes in Note II. of the Appendices to this Report. From the latter Report it appears that Craigo dyke is not constructed in accordance with the bye-law (Schedule G, 31 and 32 Vic. c. 123); and that at Morphie dyke the unavoidable difficulty which salmon experience in ascending every fish-pass is increased by the want, under normal conditions, of a sufficient volume of water to attract them, the deficiency being caused (*a*) by the substitution of turbines in place of water wheels, and (*b*) by the exemption, under Sec. 12 of the Act of 1868 (31 and 32 Vic. cap. 123), of the Kinnaber lade from the provisions of the bye-law as to the closing of sluices. It is satisfactory to note from his general report that steps were taken during last year, in the districts of the South Esk, Deveron, and Kyle of Sutherland, to unite the divergent interests which have hitherto stood in the way of the better regulation of the fishings in the confined waters. The improvement in the fisheries, as we pointed out in our Eleventh Annual Report, which have followed in those cases where the general interests have been studied instead of the individual appear to indicate that the salmon fisheries are capable of development, not only to the benefit of each proprietor, but also to the increase of the food supply, if united action were more generally adopted. An example of the low value to which salmon fishings may fall, when District Boards neglect to enforce the provisions of

p. 50.

STATEMENT OF NUMBER AND WEIGHT OF FISH CAUGHT AT SALMON FISHINGS BELONGING TO THE ABERDEEN HARBOUR COMMISSIONERS.

Season.	Salmon.				Grilse.				Sea-Trout.				Total.			
	No.	Weight in lbs.	Total Weight for each period of 7 Years.	* Percentage.	No.	Weight in lbs.	Total Weight for each period of 7 Years.	* Percentage.	No.	Weight in lbs.	Total Weight for each period of 7 Years.	* Percentage.	No.	Weight in lbs.	Total Weight for each period of 7 Years.	* Percentage.
1872	3,981	59,303	.	.	5,923	27,338	.	.	2,512	5,041	.	.	12,416	91,682	.	.
1873	4,200	48,895	.	.	7,239	34,598	.	.	2,518	4,755	.	.	13,957	88,248	.	.
1874	8,100	88,398	.	.	6,187	27,219	.	.	1,671	3,307	.	.	15,958	118,924	.	.
1875	5,961	63,987	.	.	4,714	20,501	.	.	1,163	1,922	.	.	11,838	86,410	.	.
1876	2,873	33,788	.	.	9,184	39,297	.	.	2,710	5,058	.	.	14,767	78,143	.	.
1877	4,811	55,086	.	.	7,737	37,556	.	.	1,320	2,540	.	.	13,868	95,182	.	.
1878	8,918	116,308	465,765	.	3,350	14,446	200,955	.	3,524	6,553	29,176	.	15,792	137,307	695,896	.
1879	1,897	22,964	.	.	7,284	31,141	.	.	1,606	2,785	.	.	10,787	56,890	.	.
1880	4,178	43,587	.	.	5,410	23,720	.	.	2,160	4,123	.	.	11,748	71,430	.	.
1881	4,873	47,191	.	.	11,400	49,349	.	.	3,518	6,627	.	.	19,791	103,167	.	.
1882	6,530	62,717	.	.	7,415	32,413	.	.	2,815	5,644	.	.	16,760	100,774	.	.
1883	6,886	70,384	.	.	13,852	70,555	.	.	4,330	7,969	.	.	25,068	148,908	.	.
1884	5,424	64,866	.	.	6,129	27,817	.	.	3,164	5,646	.	.	14,717	98,329	.	.
1885	4,597	53,989	365,698	78·5	15,129	73,958	308,953	153·7	5,424	9,529	42,323	145·1	25,150	137,476	716,974	103
1886	6,370	68,536	.	.	9,583	39,502	.	.	2,321	4,218	.	.	18,274	112,256	.	.
1887	5,052	55,535	.	.	14,847	60,644	.	.	3,341	5,498	.	.	23,240	121,677	.	.
1888	7,843	83,292	.	.	12,905	58,653	.	.	2,235	3,825	.	.	22,983	145,770	.	.
1889	5,623	60,573	.	.	9,336	38,379	.	.	1,282	2,199	.	.	16,241	101,151	.	.
1890	7,085	66,114	.	.	9,220	43,140	.	.	4,570	8,717	.	.	20,875	117,971	.	.
1891	9,477	107,566	.	.	11,775	58,318	.	.	2,702	4,531	.	.	23,954	170,415	.	.
1892	8,594	88,932	530,548	113·9	11,329	48,620	347,256	172·8	1,329	2,115	31,103	106·6	21,252	139,667	908,907	130·6
1893	6,795	71,185	.	.	5,068	18,131	.	.	3,513	5,294	.	.	15,376	94,610	.	.
1894	4,581	45,932	.	.	6,277	28,020	.	.	4,196	7,166	.	.	15,054	81,118	.	
1895	7,002	75,603	.	.	14,938	76,836	.	.	2,566	4,497	.	.	24,506	156,936	.	.
1896	10,790	122,746	.	.	9,766	41,426	.	.	2 851	4,771	.	.	23,407	168,943	.	.
1897	4,834	50,218	.	.	4,060	16,948	.	.	2,007	3,257	.	.	10,901	70,423	.	.

* The weight for the first septennial period is taken at 100, and for the later periods as proportional parts of the first.

the Salmon Fisheries Acts, and allow obstructions to be placed in the way of fish reaching the natural spawning grounds, is afforded by the present condition of the fishings in the district of the river Nith, to which Mr. Archer draws attention on p. 9. The deplorable state of matters in this district is under the consideration of the Nith District Board. During last year the Glasgow Water Commissioners exercised the powers conferred on them by the Act of 1885 (48 and 49 Vic. c. 136), and took from Loch Katrine a greater quantity of water than was authorised by the Act of 1855 (18 and 19 Vic. c. 118). It has become necessary, therefore, to execute the works, and to send down into Loch Achray and the river Teith the additional quantity of compensation water provided for by the later Act. Negotiations are going on between the Commissioners and the proprietors of salmon fisheries on the river Teith regarding these matters. The District Board of the river Annan, whose attention was directed to the present state of the caulds, or dam dykes, on the Kirtle, have called upon the proprietors to alter them so as to bring them into conformity with the regulations laid down in the Commissioners' bye-law (Schedule G, 31 and 32 Vic. cap. 123).

Salmon Fishing cases in the Court of Session.

Two cases involving questions of importance to the salmon fisheries of Scotland were decided in the Court of Session and in the High Court of Justiciary, respectively, last year, viz. :—Duke of Fife and Others, and Don and Another *v.* Johnston—it being declared, in the former case, that, in the circumstances set forth, a proprietor of a right of cruive fishing is bound to alter his cruives so as to bring them into conformity with the bye-law (Schedule F, 31 and 32 Vic. cap. 123), notwithstanding that they have been maintained and used at their present size for upwards of a hundred years; and, in the latter case, that a tenant of salmon fishings is an occupier within the meaning of the Act, and cannot evade responsibility for failure to perform the statutory duty of removing the leaders of bag-nets during the weekly close time by pleading the p. 63. fault of his servants. The report of the former case is given in Note III. of the Appendices.

Sum raised and expended by District Boards.

p. 72. In Note IV. is given an abstract of the sums raised and expended by District Boards during the year ending the 15th May 1895. The information is obtained from the Annual Local Taxation Returns (Scotland) for the year 1894-95, prepared by the Local Government Board for Scotland.

Rateable Value of Salmon Fishings.

p. 74. In Note V. is given, so far as the information is available, the rateable value of the salmon fisheries in districts where Boards have been formed for the years 1881 to 1895 inclusive. In twenty districts the information is available in each of the above-mentioned years, viz. :—In the districts of the rivers Annan, Cree, Dee (Solway), Dee (Aberdeen), Deveron, Don, Esk (North), Esk (South), Findhorn, Forth, Girvan, Kyle of Sutherland, Lochy, Ness, Nith, Spey, Tay, Ugie, Ythan, and Tweed. In the following table is given the aggregate value of the fisheries in the above-named districts in the years 1881 to 1895 inclusive, the average value in each period of five years, and the proportion per cent. which the two later periods bear to the first, the value of the first being taken as 100 :—

Year.	Rateable Value of Fisheries.	Average Value in each period of Five Years.	Percentage.
	£	£	
1881	90,226		
1882	86,654		
1883	85,776		
1884	85,311		
1885	88,218	87,237	
1886	91,407		
1887	94,644		
1888	96,312		
1889	93,667		
1890	92,101	93,624	107·3
1891	90,763		
1892	90,725		
1893	94,752		
1894	99,894		
1895	98,419	94,910	108·7

Annual Close Time.

In Note VI. of the Appendices a list is given of the dates of the commencement and termination of the annual close time for net and rod fishing respectively, applicable to the salmon rivers in Scotland. p. 76.

List of Chairmen and Clerks of District Boards.

In Note VII. of the Appendices will be found a list of the Chairmen and Clerks of Salmon Fishery District Boards in Scotland. It will be observed that during 1897 Boards were formed for the districts of the rivers Broom, Doon, Gruinard and Little Gruinard, and Little Loch Broom, where none previously existed. p. 79.

Report of Investigations on the Life History of Salmon.

A Report to the Fishery Board of investigations into the life-history of salmon in fresh waters, conducted at the Research Laboratory of the Royal College of Physicians, Edinburgh, was issued as a separate Blue-book and presented to both Houses of Parliament on 8th March last. We desire to express our thanks to the several contributors for their valuable work, as well as to those noblemen and gentlemen who kindly supplied material for investigation.

We have the honour to be,

Your Lordship's most obedient servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
JOHN MURRAY.
J. RITCHIE WELCH.
W. R. DUGUID.
ARCHIBALD JAMESON.
L. MILLOY.

WM. C. ROBERTSON, *Secretary.*

SALMON FISHERIES.

APPENDIX.

SIXTEENTH ANNUAL REPORT TO THE FISHERY BOARD FOR SCOTLAND.

ON THE

SCOTTISH SALMON FISHERIES IN 1897

BY

WALTER E. ARCHER, F.R.S.E.,
Inspector of Salmon Fisheries for Scotland.

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REPORT.

I HAVE the honour to submit my Annual Report to the Fishery Board for Scotland for the year 1897.

North Esk.

In accordance with my instructions, I visited the river North Esk on the 16th July, and on the 16th and 18th October last, for the purpose of reporting on the state of Craigo and Morphie dam dykes and the bed of the river in their immediate neighbourhood. My report on this matter is given in Note II. of the appendices. Craigo dyke has for a number of years formed a serious obstruction to the passage of salmon to the upper waters, and was strongly condemned by my predecessor, Mr. Young, in a report to the upper proprietors, dated as far back as the 10th February 1882, which is printed as Appendix V. to the Board's First Annual Report. Although some alterations were made in the following year, they were not effectual, and the dyke still forms a most formidable obstruction. The District Board have now taken the matter in hand, and, since they have undertaken that their action will be regulated by the terms of the report which they received from the Fishery Board, it is to be hoped that efficient steps will immediately be taken to provide a free passage for salmon in terms of the bye-law.

South Esk.

After leaving the North Esk, I proceeded, on the 17th July, to the South Esk. The late Mr. Frank Buckland is reported to have said in 1870, of this river and its tributary streams, that it was naturally the best river of its size he had seen in Scotland for breeding salmon, and the worst treated. Much has been done for its improvement since that time, particularly by the establishment of a sewage farm with the view of stopping pollution, and by the construction of an efficient fish-pass at Brechin Castle dam dyke, formerly a most serious obstruction. The increase in the rental of the fishings shows that the steps which have been taken have proved successful. In 1874 the rental was £1536 ; it is now £3149. It is satisfactory to find that the proprietors in this district, who have hitherto shown such energy and judgment in the management of their fishings, are in the van of the movement recommended by the Royal Commission on Tweed and Solway for the further development of the capabilities of their river for the production of fish ; and have come to an arrangement by which, in future, netting in confined waters will be discontinued and the river be kept for the breeding of fish, rod fishing only being allowed. The proprietors are to be congratulated on this step. In other districts where it has been adopted it has been followed by the improvement both of the net fishings in the sea and of the rod fishings in the river.

Where so much has been done for the development of the fishings it is disappointing to find that such a small matter as providing efficient fish-passes at some of the dam dykes has been neglected. In my Report to the Board for the year 1892 I point out that at Kinnaird dam I saw numbers of salmon attempting in vain to ascend, and that the fish-pass appeared quite inoperative. Nothing, however, has been done to improve it. The dam, which is curved in shape, is about five feet high, and presents, except at certain levels of the river, a considerable obstruction to the passage of fish. The face of the dam is about twenty-seven feet broad, sloping, for the upper half of its breadth, at an angle of about one in four, and for the lower half at about one in seven. The fish-pass is nothing more than a depression, a few inches deep, on the face of the dam, and, in its present condition, cannot possibly afford a free passage to fish at all times in terms of the bye-law (Schedule G). What is required is the erection of three small subsidiary dams in the angle formed by the curve of the mill dam. The fall from the crest of one to the crest of the other should not exceed fourteen inches; they should not be less than ten feet apart; and there should be at least three feet depth of water in the pools formed between each. The cost would be trifling if they were constructed in the same manner as those at Mile End Weir, Llangollen, on the river Dee (Cheshire), of which a plan is given in the Thirty-fifth Annual Report of the Inspectors of Fisheries (England and Wales). East Mill dam is not such a serious obstruction, but its ascent might be greatly facilitated if similar subsidiary dams were placed in the angle which it forms with the right bank of the river. At Blaikie mill dam the provision of the bye-law with regard to the construction of a fish-pass is altogether disregarded, while at Finavon the pass is inefficient. Further, although at neither of the two last-mentioned places were the mills working at the time of my inspection, yet in each case a greater volume of water was running to waste through the lade than was flowing over the dam; and I was informed that the provisions of the bye-law (Section 2, Schedule G) as to the shutting of sluices when the mills are not working are habitually contravened. These matters require the attention of the South Esk District Board, as it would seem, after the decisions given in the Court of Session in the cases of Kennedy *v.* Murray, 1869, 7 Macph. 1001; Myers *v.* Grant, 1871, Scot. Law Reporter, Vol. VIII., p. 404; and Duke of Fife and others, 1897, Scot. Law Reporter, Vol. XXXIV., p. 440, that District Boards should have no difficulty in enforcing the provisions of the Commissioners' bye-laws, and that they have, therefore, now no excuse for neglecting to do so. The provisions of the bye-law (Schedule G), and the requirements which modern experience has shown are necessary in order to produce an efficient pass, are discussed at length in my Report on Craigo and Morphie dam dykes which is appended in Note II.

In a prosecution raised by the South Esk District Board an important point of law was decided, on appeal, by the High Court of Justiciary, with regard to the liability of a tenant, or occupier of salmon fishings, for offences committed by a servant against orders. The offence complained of was a breach of the regulations with regard to the weekly close time by neglecting to take out of the water the leaders of certain bag-nets. The Court held that the 24th Section of the Act of 1868 (31 and 32 Vic. cap. 123), and the 3rd Section of Schedule D appended to that Act, lay a statutory duty on occupiers of salmon fishings to remove their nets during the weekly close time, and that a tenant of salmon fishings is an occupier within the meaning of the Act and cannot evade responsibility for failure to perform that duty by pleading fault on the part of his servants (Don and another *v.* Johnston, Scots Law Times, Vol. V., 296 App.)

Deveron. From the South Esk I went to the Deveron to advise the District Fishery Board as to the alteration of the cruives, which the Court decided, in the special case referred to in my last Annual Report, must conform to the regulations contained in the Commissioners' bye-law

(Schedule F, 31 and 32 Vic. c. 123). The alterations have, however, since become unnecessary, as the District Board, by agreement with the proprietor, have purchased the cruives and cruive dyke for the purpose of removal, in terms of the 13th Section of the Act of 1868. The work of demolition was completed before the commencement of the fishing season, and the formidable artificial obstruction which has hindered the passage of fish for upwards of a hundred years is now removed altogether. The decision given in the above case (Duke of Fife and others, 23 February 1897) is of considerable importance to District Fishery Boards, bearing as it does on the question of how far the clause at the end of Section 6 of the Act of 1862 (25 and 26 Vic. cap. 97) affects the regulations made by the Commissioners with regard to the construction and use of cruives—a question discussed at some length in a memorandum with regard to the law relating to cruives, which is printed in Note III. of the Appendices to the Thirteenth Annual Report of the Fishery Board, Part II. By the clause referred to the regulations made by the Commissioners are subject to an important qualification, viz., "that such regulations shall "not interfere with any rights held, at the time of the passing "of this Act, under Royal grant or charter or possessed from "time immemorial." From the opinion expressed by the Lord President, it would seem, in effect, that the mere fact of cruives having been of a particular size for upwards of a hundred years does not give a right of immemorial possession in the sense of the Act, and that, in absence of a right under charter to any particular size or description of cruive, cruives must be constructed in accordance with the regulations made by the Commissioners. The report of this case is given in Note III. of the appendices.

Kyle of Sutherland.

I next visited the district of the Kyle of Sutherland, where I was met by Mr. Main, the Superintendent of Salmon Fisheries to the District Board, who accompanied me in my inspection. In this district a new procedure was instituted during last fishing season. A syndicate of those interested in the rod fishings in the upper waters obtained a lease of the valuable net fishings at Bonar Bridge, with a view of regulating them so that an increased number of fish may have access to the upper waters during the net fishing season. Instead of the statutory weekly close time of 36 hours, a weekly close time, beginning at 6 p.m. on Friday and terminating at 6 a.m. on Monday, has been observed. With the exception of two stations at the mouth of the Carron, the same number of stations were worked, and they were fished in the same manner as before. The fishermen, I am informed, have suffered no loss through this arrangement, as they are paid the same wages for fishing five days as they formerly received for fishing six days a week. This scheme of leasing the net fishings in the lower waters by those interested in the upper would seem to be a happy solution of the questions in dispute between upper and lower proprietors, and to be worthy of imitation in other districts. It tends to prevent overfishing and to promote united action for the development of the fisheries. In rivers which are overfished it seems, also, to be a wise and remunerative policy. The increased value of the angling waters makes up for the immediate loss incurred by restricting netting, while the protection of a larger number of breeding fish, by increasing the production of fish, should improve the yield of the net fishings in future years.

Loch Katrine.

On the 26th July I inspected the works erected by the Glasgow Waterworks Commissioners at the outlet of Loch Katrine, and subsequently had an interview at Dunblane with Mr. Barty, who is representing the proprietors of salmon fisheries on the river Teith in the negotiations which are going on between them and the Commissioners regarding the new works which are about to be constructed.

By the 16th Section of the Glasgow Corporation Waterworks Act, 1885 (48 and 49 Vic. c. 136) the Commissioners, under that Act, are entitled to raise the water in Loch Katrine five feet above the *maximum* height specified in the 55th Section of the Act of 1855 (18 and 19 Vic. c. 118), and, by the 17th Section of the former Act, to take from the loch 110,000,000 gallons of water per diem, including in that quantity the 50,000,000 gallons which they are authorised to take by the 57th Section of the latter Act. The right to raise and take the said water is subject, however, to the qualification that not less than 800,000 cubic feet of water are discharged daily from Loch Katrine into the Achray Water, and 6,720,000 cubic feet of water from Loch Vennachar into the river Teith; while, in the construction of the embankment for raising the water in Loch Katrine, provision must be made to allow fish to pass freely into or from the loch.

Until last year the powers conferred by the Act of 1885 had not been exercised, but since then a greater quantity of water has been taken than was authorised under the earlier Act, and it has become necessary to construct the works authorised by the later Act. It would seem that three points should be kept in view in their construction, viz.:—(1) That provision be made to ensure that the requisite compensation water be made to flow from Loch Katrine into the Achray Water, and from Loch Vennachar into the river Teith; (2) that proper water gauges be erected, in order that the amount of water sent down may be checked; and (3) that the dam shall be so constructed as to allow fish to pass freely to and from the loch in terms of the 27th Section of the Act of 1885.

With regard to the regulation of the compensation water, it would seem to me that greater accuracy would be insured, and much inconvenience obviated, if the water gauges were made self-recording, as they might be made without any great difficulty. The raising of the level of Loch Katrine will render the existing salmon ladders altogether useless, and in order to allow fish to pass freely into and from the loch it would seem to me that the old channel should be made use of, and subsidiary dams erected across it, as has been done in the case of the old channel leading from Loch Vennachar. But, if this is done, it will be necessary to send the compensation water down the old channel instead of through the new cut as is done at present. Otherwise, fish will be unable to ascend "at all times, or during such period as water shall be "discharged from Loch Katrine," in terms of the 27th sec. of the Act of 1885. But since the water in Loch Katrine may be lowered twelve feet below its *maximum* height, and the outlet for the compensation water must be placed below the lowest point to which the loch may be lowered, it is evident that the compensation water cannot be made to flow over the subsidiary dams in the ordinary manner; and I am disposed to think, therefore, that this is a case in which Cail's system of fish-pass might with advantage be adopted.

From Dunblane I proceeded to Kirtlebridge, in Dumfriesshire, stopping at Stirling on my way for the purpose of conferring with the Clerk of the District Board of the river Forth, of which the river Teith is a tributary, regarding the erection of a suitable fish-pass at the outlet to Loch Katrine, and the other points which should be kept in view during the construction of the new works.

Kirtle. On the 28th July I visited the cauls on the river Kirtle, being accompanied on my inspection by General Graham of Wyseby and Mr. Andrew Smith, factor to Mr. J. E. Johnson-Ferguson, M.P. There are three cauls on this river, viz.:—One at Kirtlebridge, belonging to Colonel Irvine of Burnfoot; a second at Beltenmount, of which Miss Beattie, residing at Annan, is proprietrix; and a third at Rigg, in the parish of Gretna, which is owned by Lord Mansfield. The first and second are used for the purpose of meal mills, but the third is not used for milling purposes at all, the mill in connection with it having been done away with a number of years ago, and the mill lade allowed to silt up. It would seem, therefore, that it is simply an obstruction to the passage of salmon, and that any person having the right of salmon fishing in the river may sue for its removal. In the case of the cauls at Kirtlebridge and Beltenmount the provisions of the Commissioners' bye-laws (Schedule G, 31 and 32 Vic. cap. 123) are totally disregarded. There are no fish-passes on the cauls, no hecks on the mill lades, and the water is allowed to run to waste when the mill is not working, instead of being sent over the mill dam as provided in the bye-law. The attention of the District Board has been directed to the condition of these cauls.

Nith.

The Nith District Board have had under consideration the best method of dealing with some of the dam dykes which at present greatly obstruct the passage of salmon to the upper waters. By the direction of the Fishery Board I attended a meeting of the District Board when these matters were being discussed, and subsequently made an inspection of the river from Sanquhar to Dumfries, and of the various tributaries flowing into it.

In point of size the Nith ranks as one of the largest of the second-class salmon rivers of Scotland. But its salmon fishings, judged by their rateable value (see Note V.) would seem to be among the least productive, if those of such rivers as the Clyde, in which salmon are entirely extinct, are excluded. Nor is this surprising, seeing the difficulties with which the parent salmon have to contend in ascending the river and the large extent of spawning ground from which they are entirely excluded. During the open season comparatively few salmon escape capture, owing to the serious obstruction caused by Dumfries cauld and to the netting which, I am informed, is prosecuted in the confined waters below. During the close season those salmon which succeed in ascending Dumfries cauld are cut off by impassable obstructions from the spawning grounds in most of the tributary streams. In fact, since I first visited Sand's river in 1883, I have not seen a salmon river where greater difficulties have been placed in the way of salmon reaching the natural spawning streams, or where, if steps were taken for the improvement of the fishings similar to those adopted on Sand's river, they would be more likely to lead to the same successful results. The steps referred to are described in Note II. of the Eleventh Annual Report of the Fishery Board for Scotland, Part II., and the results up to and including 1893 in Note VI. of the Board's Thirteenth Annual Report. Since 1893 the improvement of the fishings is even more marked than before. With regard to these steps and their results, it is sufficient to say here that the facilitating of the passage of fish over the several obstructions and the placing of the net fishing under such regulations as enabled a portion of every run of fish to reach the upper waters and secured their protection when there, was followed by the net fishings yielding nearly three times the quantity of fish which they formerly did; whilst first-rate angling was obtained in the river, where previously only few fish were caught. The account given in these Reports, as well as that given with regard to the Dee (Aberdeenshire) and the rivers of the west coast of Sutherlandshire on pp. 7 and 8 of the Fourteenth Annual

Report, are worthy of the careful consideration of the proprietors of the salmon fishings in the river Nith.

In the following table is given a list of the principal obstructions, together with the name of the tributary on which they are situated:—

Obstruction.	Stream.	Remarks.
Dumfries Cauld . .	Nith.	Salmon-pass not in accordance with regulations in bye-law (Sch. G).
Closeburn Mill Dam .	Cample Water.	Bye-law (Sch. G) entirely disregarded. Mill disused.
Carron Foot ,, .	Carron Water.	Bye-law (Sch. G) entirely disregarded. Total obstruction.
Holestane ,, .	,,	Bye-law (Sch. G) entirely disregarded. Total obstruction.
Enterkin ,, .	Enterkin Burn.	Bye-law (Sch. G) entirely disregarded. Total obstruction.
Menock ,, .	Menock Water.	Bye-law (Sch. G) entirely disregarded. Mill disused.
Crawick Upper Dam .	Crawick Water.	Bye-law (Sch. G) entirely disregarded.
,, Lower ,, .	,,	Do.
Euchan Mill Dam . .	Euchan Water.	Fish-pass not in accordance with regulations in bye-law (Sch. G) Mill disused.
Cairn ,, . .	Scaur Water.	Fish-pass not in accordance with regulations in Bye-law (Sch. G).
Shinnell ,, . .	Shinnell Water.	Bye-law (Sch. G) entirely disregarded.
Cluden ,, . .	Cairn Water.	Do.
Cluden Cruives . .	,,	Not constructed in accordance with regulations in bye-law (Sch. F).
Cruden Rocks Mill Dam	,,	Partly natural. Practically impassable.
Delgoner Meal ,,	,,	Bye-law (Sch. G) entirely disregarded.
,, Saw ,,	,,	Do.

In but three of the fifteen mill dams above enumerated has any attempt been made to comply with the provisions of the bye-law. The fish-pass on the Dumfries cauld at present lacks one of the chief requisites of success—viz., an attractive entrance in a proper position. Further, the fall from one pool to another is greater than is desirable in a properly constructed pass, while the pools are not of sufficient depth. The fish-pass on the Cairn mill dam does not afford a free passage to fish in terms of the bye-law, and falls short of its *minimum* requirements in the following respects, viz.:—First, the upper sill of the pass is level with the crest of the dyke instead of being not less than six inches below its lowest part; second, the gradient of the pass is steeper than five horizontal to one perpendicular; and third, the foot or entrance to the pass projects beyond the toe of the dam. The down stream face of the mill dam on the Euchan, instead of sloping at a uniform gradient throughout, is made in four steps, and the fish-pass is formed by dishing or hollowing out a pool in each step. But owing to the pools being too shallow, and the steps too high, fish would have great difficulty in ascending. Further, there is no cutting in the crest of the dam where these pools are situated, and the gradient of the fish-pass is steeper than the maximum permitted in the bye-law. In the case of the other mill dams in the district no attempt has been made to carry out the regulations contained in the bye-law. With regard to the cruive at Cluden, I am informed that the proprietor holds, as was held by the proprietor of the cruives on the Deveron previous to the recent decision in the Court of Session (Duke of Fife and others, 1897), that, in virtue of his titles and of the proviso at the end of Section 6 of the Salmon Fisheries (Scotland) Act, 1862, he is entitled to maintain and use his cruive in the form in which it has been maintained from time immemorial. According to this decision, however, it would seem that cruives must conform to the regulations contained in the bye-law, unless a right under charter to any particular size or description of cruive can be shown. I have been in correspondence with the District Board as to the alterations which are necessary to provide a free passage for the fish over these obstructions.

Immediate results from improved regulations should not be expected.

It is satisfactory to note that there seems a general movement on the part of proprietors of salmon fisheries towards amalgamating the conflicting interests which have hitherto stood in the way of regulations being adopted for the protection of a proportion of every run of salmon. During last year steps have been taken in this direction in the districts of the Kyle of Sutherland, the Deveron, and the South Esk, either by lengthening the weekly close time, by removing obstructions, or by abolishing netting in confined waters; while similar steps have been carried out in other districts in previous years, or are still under consideration. The evidence which I have put forward from time to time in my reports to the Board (Eleventh Annual Report, pp. 11 and 59; Thirteenth Annual Report, p. 82; and Fourteenth Annual Report, pp. 7 and 8) seems to show that, in those districts where this principle has been adopted, it has been followed by the improvement of the fisheries both in the tidal as well as in the non-tidal waters. Those, however, who expect great and immediate results will probably be disappointed. Nothing seems to be surer with regard to the effect of regulations for the improvement of the fisheries than that the result only shows itself by good years becoming better and bad years not so bad; and, further, that the full benefit of such regulations is not felt until eight or ten years after their introduction. Thus, if the statement of the number and weight of the fish caught at the salmon fishings belonging to the Aberdeen Harbour Commissioners be studied, it will be seen that in only two, out of the first nine years after the new regulations were adopted, did the yield of fish exceed 100,000 lbs., whereas in the subsequent seventeen years it only fell short of that quantity in four years (p. x., *ante*). On the Ballisodare River in Ireland, where an entirely new salmon fishery was created by opening up the obstructions at the mouth and allowing the fish to have free access to the spawning grounds above, it seems to have been eleven years before the fisheries were fully established (Tenth Annual Report, p. 11). On the Galway River, where Mr. Thomas Ashworth enormously increased the value of an existing fishery by opening up a large extent of spawning ground by means of ladders, it was nine years before the marked increase became apparent (Tenth Annual Report, p. 13). On Sand's River in Norway the average annual take of fish in the ten years following the adoption of the new regulations was not half what it has been in subsequent years (Eleventh Annual Report, p. 59). The evidence afforded by these examples would seem to show that no immediate results are to be looked for from any regulations which may be adopted, and that proprietors should not be discouraged even though no improvement is apparent for nine or ten years.

Artificial Hatching of Salmon.

In the Bulletin of the United States Fish Commission for 1896 (Vol. XVI.), Mr. Livingstone Stone, who has been connected with the fish-hatching operations on the Pacific Coast since their earliest commencement, furnishes an interesting and instructive report on the salmon-breeding work of the United States Fish Commission on that coast. He gives a brief history of the hatching operations at Baird Station, California, from 1872 to the present time, and describes the growth of the hatchery, the means adopted for capturing and retaining the breeding salmon, the packing and shipping of the eggs, and the vicissitudes of each season's spawning operations.

From 1872 to 1883 inclusive, eggs from the Baird Station were for the most part transported across the continent of America and the fry deposited in the rivers flowing into the Atlantic. With regard to the result of this experiment Mr. Stone writes as follows, viz.:—

> "When the work of the United States Fish Commission in salmon breeding "was begun on the Pacific Coast, it was supposed that that coast had enough "salmon to spare, and it was the intention of the Commission to increase the "salmon on the Atlantic Coast by restocking its depleted salmon rivers. The "highest hopes were entertained of doing that after it had become an accomplished fact that millions of salmon eggs had been procured on this coast, and "that they had been safely transported across the continent to the Atlantic "rivers. I doubt if there was one person who heard about it in America, whether "interested in fish culture or not, who did not believe that salmon were going to "become abundant again in the Atlantic rivers on account of the introduction of "Pacific Coast fish; and not only this, but many persons believed that several "Southern rivers that had never had any salmon in them before, would become "prolific salmon streams, when they were well stocked with this new Californian "salmon that abounded in warm latitudes on the Pacific Coast. That this did not "prove to be the result was a stupendous surprise and disappointment. The eggs "hatched out beautifully. The young fry, when deposited in the fresh-water "streams, seemed to thrive well. They grew rapidly, and when the proper time "came were observed to go down in vast numbers to the sea. What afterwards "became of them will remain forever an unfathomable mystery. Except in rare "isolated instances, these millions of salmon were never seen again. What "became of them? Where did they go? Are any of them still alive in the "boundless ocean? Or are they all dead? And if they are dead, what killed "them? Much as this information has been desired, there lives no one who can "answer these questions. Some have thought that they wandered off to the far "North, and so became lost to the civilised world. Others that they strayed out "into the ocean and were devoured by marine animals and larger fish. Professor "Baird once jokingly remarked to the writer that he thought they had found an "underground passage beneath the continent, and had returned by it to the "Pacific. One thing is certain, and that is that these millions of salmon have "disappeared as completely from the Atlantic Ocean and its tributaries as if they "had been devoured years ago by the monsters of the deep."

The result of this experiment would seem to be of more than ordinary interest when it is taken into consideration (1) that in ten years, viz.:—from 1872 to 1881 inclusive, 31,193,000 eggs were transported from Baird Station on the M'Cloud River, and 22,504,035 young fry were actually introduced into the rivers on the Atlantic seaboard (*op. cit.*, 228), and (2) that *Salmo quinnat* did not previously exist in the Atlantic rivers, and that had, therefore, any appreciable number returned as adult salmon they could hardly have escaped notice.

With regard to the value of artificial hatching as a means of maintaining the productiveness of existing fisheries, Mr. Livingstone Stone states:—

> "That although Nature has evidently designed that the quinnat salmon shall "not take up its abode on the American shores of the Atlantic, the breeding of "this fish seems to serve a legitimate and useful purpose in keeping up the supply "of its species in its native waters of the Pacific Slope; especially in view of the "enormous drafts made upon these fish by the canneries and by the yearly "increasing consumption of fresh and salted salmon."

Mr. Stone's remarks on this point must necessarily carry little weight, as the result of any attempt to increase the productiveness of existing fisheries must always be doubtful even when statistics are available over long and consecutive periods of years; but when, as in this case, the alleged results are arrived at by comparison of the yield of the fisheries in a few selected years no value can be attached to them (*op. cit.*, p. 229).

Salmon Fishery Investigation.

The report § of the investigations conducted at the Research Laboratory of the Royal College of Physicians by Dr. Noël Paton and his colleagues into the life-history of salmon in fresh waters, referred to in my last Annual Report, was issued as a separate paper, and presented to both Houses of Parliament on 8th March last. This report forms a most valuable addition to our knowledge, it throws important light on several questions of great practical interest, and should assist greatly in furnishing exact information on which to base regulations for the improvement of the salmon fisheries. Since these investigations form part of a plan of investigation begun in 1894 with the object of ascertaining the value for breeding purposes of fish entering the rivers at different seasons of the year, it would not seem out of place at this time to consider very briefly how the facts which have been ascertained bear on this subject.

Professor Meischer Ruesch, of Basle, seems to have been the first authority to make a systematic study of the question. The salmon examined by him were mostly caught in the neighbourhood of Basle, in Switzerland, over 500 miles from the sea.* The observations begun by him were, in part, continued by Dr. Hoek,† Scientific Adviser on Fisheries to the Dutch Government, who examined the condition of salmon taken at the mouth of the Rhine, and corrected several of the conclusions Professor Meischer Ruesch had erroneously arrived at, owing to his want of data as to the condition of salmon in, or just after leaving, the sea. The investigations made by Mr. Grey in 1894 and Mr. Tosh in 1895,‡ at Berwick-on-Tweed and Kelso, enabled it to be seen how far those made on the Rhine are likely to apply to salmon in this country, and paved the way for the important work § which has been carried out during 1896 by D. Noël Paton, James C. Dunlop, A. Lockhart Gillespie, G. Lovell Gulland, E. D. W. Greig, S. C. Mahalanobis, and M. T. Newbiggin. The salmon examined by Dr. Noël Paton and his colleagues were procured simultaneously from the mouths and upper waters of rivers, thus enabling the fish from the former locality to be compared with those from the latter.

The object of these investigations has been (1) to trace the growth of genital development in salmon, both in the sea and in fresh water, from its earliest commencement to its fully ripe condition; (2) to determine the source from which the material used in the construction of the genital organs, and from which the energy required by fish in ascending rivers and during their sojourn there, is derived; and (3) to ascertain the difference in the length, weight, condition of muscle, genitalia, or other organs in fish coming in from the sea, and in fish which have reached the upper waters, respectively, with the view of seeing whether

* Statistische und biologische Beiträge yur kenntniss von heben das Rheinlachses im Sussvater. Dr. F. Meischer Ruesch, Prof. d. Physiol. in Basel. Publishers: Druck von Metrjger & Wittig, Leipsig.

† Rapport over Statistische en biologische onderzoekingen ingesteld met behulp van in Nederland gevangen Zalmen. Dr. P. P. C. Hoek, Wetenschappelijk Adviseur in Visscherijyaken.

‡ Appendices to Fourteenth Annual Report of the Fishery Board for Scotland, Part II., pp. 9 to 31.

§ Report of Investigations into the Life-History of Salmon in Fresh Water. Edited by D. Noël Paton, M.D., Superintendent of the Laboratory of the Royal College of Physicians of Edinburgh.

the difference is sufficiently marked to enable the former to be distinguished from the latter and to afford a guide as to the date of the immigration of the latter from the sea.

The evidence which has been adduced may be divided under two heads, viz. :—First, as to the question of whether salmon entering the rivers in spring *can* develop ripe ova and milt without revisiting the sea; and, second, whether they *do* remain in fresh waters until the spawning season, and, if so, whether they form the breeding stock in the head waters of the rivers, leaving the lower reaches for the later arrivals.

With regard to the first question :—

1. The greater weight of the genital organs in "clean" salmon taken in March and April, as compared with those in kelts, shows that the growth of these organs has already begun in fish coming in from the sea in the early months; and the gradual increase in the weight of these organs in every succeeding month, that growth proceeds with great regularity until maturity is reached. Every different stage of development seems to be represented in the specimens which have been examined, and the small size of the genital organs in the early months would seem to be simply due to their being at that time in the earlier stages of development (Fourteenth Annual Report, pp. 14 and 16; Special Report, pp. 68, 72, and 74).

2. The greater weight of the genital organs in fish taken in the upper waters, as compared with those in fish taken at the mouth in the same period, denotes that not only has development not been arrested in fish which entered the fresh water early in the season, but on the contrary that it has advanced further in them than in the later arrivals (Special Report, pp. 68 and 72).

3. The experiments conducted on the river Aaensira in Norway show clearly that salmon entering the fresh water in June, when the genital organs in females are one-tenth, and in males one-thirteenth, of their ripe weight, can develop ripe ova and milt without revisiting the sea (Twelfth Annual Report, p. 55; and Fourteenth Annual Report, p. 14).

4. The diminished weight of fats and proteids in fish taken in the upper waters in October and November as compared with fish coming in from the sea between May and August, the atrophied condition of the lining membrane of the stomachs and intestines, and the very low digestive power of these organs, show that the material used in the construction of the genitalia and the source of energy required during the sojourn of the fish in fresh water are derived from the fats and proteids stored in their bodies, thus making them independent of food while in the river (Special Report, pp. 13, 23, 36, 93, 120, and 170).

With regard to the second question, Dr. Noël Paton draws attention, in the first place, to the length of the fish supplied from the upper and lower waters respectively (Special Report, pp. 68 and 75). He points out that "the length of the fish coming to the mouth of the river is "practically the same from May to August. But in October and "November a markedly larger class of fish appears in the estuaries. In "the upper reaches, however, the size of the fish remains constant until "October." Since, in the case of the fish he examined, fish of a particular size were asked for, the circumstance of large fish being sent from the mouth and small fish from the upper waters does not prove that large fish were not present in the upper waters, or that they might not arrive there a few weeks later. But it does appear to show that fish of the desired size were not coming in from the sea in October and November, which conclusion is supported by the figures given in Tables I., II., and XI. (Special Report, pp. 10, 11, and 69), and that the smaller class of fish, therefore, which were present at that time in the upper waters must have entered the river, at any rate, before the end of August. It also seems to lay the foundation for the complete solution of the question of whether the early fish form the breeding stock in the upper waters, leaving the lower reaches for the later arrivals. For, if it is the case, as these investigations seem to show, (1) that there is a marked difference in the size of fish entering the rivers in different periods of the year (Special Report, pp. 10 and 69), and (2) that they do not increase in length during their sojourn in fresh water (Special Report, p. 171), then, given the average length of fish entering the river in each period, and that of fish frequenting the different tributaries or parts of the main river at spawning time, it will be possible to show whether or not fish frequenting any tributary, or part of the main river, correspond in length with those entering the river in any particular season of the year.

Dr. Noël Paton refers in the second place to the very marked difference in the weight of the muscle of fish in the upper waters in October and November, as compared with those coming in from the sea, as an indication that the immigration of the more muscular fish from the sea to the upper water practically ceases in the autumn (Special Report, p. 75). But, as was pointed out when discussing the length of fish taken in the upper waters, the fact of fish with greater muscular development not being sent from the upper waters for examination does not prove that they were not there, seeing that the fish sent were selected of a particular size, and, as has been shown, the more muscular fish coming in from the sea in the autumn were larger than was required, and would probably, therefore, not have been sent so long as the smaller-sized fish were procurable.

The marked difference in the muscular development of the upper and lower water fish respectively does, however, appear to tell strongly against the theory of any *general* to-and-fro migration between river and sea. If it is the case, as these investigations seem to show, that salmon continue to feed in the sea, and cease feeding, or, at any rate, in utilising any food which they swallow, after they enter the rivers (Special Report, p. 171), then it follows that the longer they remain in fresh water the greater will be the loss of muscle. If, therefore, any such to-and-fro migration were general, we should expect that the amount of muscle expended in reaching the upper waters would in each period have been about the same, and not, as is shown in Table VII. (Special Report, p. 67), that the differences in the weight of the muscle between fish taken at the mouth and those taken in the upper waters should become more and more marked as the season advances. The ever-increasing difference as the season advances in the weight, weight of muscle, and weight of solids in the muscle would seem to indicate that, even if *some* of the more muscular fish coming in from the sea in the autumn ascend to the upper waters, and *some* of the salmon which entered the rivers early in the year return again to the sea, among those frequenting the upper waters from May to November there are a large number which remain there drawing upon the material stored in their bodies for the construction of their ovaries and for their supply of energy (Special Report, pp. 66, 77, and 86).

Lastly, the marked difference which is shown in the weight of the ovaries in upper-water as compared with lower-water fish seems to show that the same fish are not passing to and fro between river and sea, but rather that the fish supplied from the upper waters in October and November with the large weight of genitalia and the small muscular development are the fish which ascended the river in the earlier months, and which would spawn at a somewhat earlier date than those supplied in the same months from the lower waters ; and an analysis of the average weights of the muscle and of the ovaries strongly supports such a conclusion (Special Report, pp. 68 and 77).

I have the honour to be,

Your obedient Servant,

WALTER E. ARCHER.

The Fishery Board for Scotland,
15*th April* 1898.

NOTE I.

THE FOLLOWING QUERIES HAVE BEEN SENT TO CLERKS OF DISTRICT BOARDS:—

Take of Fish—

1. Has the take of fish in your district in 1897 been above, about, or below the average—
    - (*a*) In tidal waters?
    - (*b*) In fresh waters?
    - (*c*) In fixed engines?
    - (*d*) Generally throughout the district?

2. Can you give the number of fish caught in your district, exactly or approximately—
    - (*a*) By net and coble?
    - (*b*) By fixed engines?
    - (*c*) By rods?

3. At what period of the year in your district during 1897—
    - (*a*) Were the first clean fish taken?
    - (*b*) When was the main take of salmon?
    - (*c*) When did the grilse and sea-trout run?

4. In order that accurate records be kept as to whether the run of salmon in your district is becoming earlier or later, it is desirable that you should, if possible, obtain and furnish me with statistics of the percentage of fish taken in each month—
    - (*a*) By net and coble?
    - (*b*) By fixed engines?

5. What was the weight of the heaviest salmon or trout caught in your district in 1897—
    - (*a*) By net and coble?
    - (*b*) By fixed engines?
    - (*c*) By rods?

Protection—

1. Please state the amount of the assessable rental of your district in 1897?
2. What was the assessment levied thereon during this year?
3. State the number of water bailiffs employed in your district in 1897?
4. Were any prosecutions instituted under the Salmon Fishery Acts in 1897? If so, for what offences were they instituted, and what was the result?

Obstructions to the Passage of Fish—

1. Give full particulars of any dams destroyed or given up in your district in 1897; or any new dams built or old dams altered?
2. Have any cruives in your district not been fished during 1897?
3. Are the dams and cruives in your district worked in accordance with the provisions of the bye-laws (Schedule F and G) regulating the same?
4. Have any fish-passes been built or altered in 1897?

5. Do the existing fish-passes afford at all, or any, or at what times a free passage to salmon wishing to ascend ?
6. Have any natural obstructions been opened up during 1897 ?
7. Generally, have any acts been done, either by new fisheries being started, old fisheries not being used, or in any other way, whereby the ascent of fish has been influenced ? If so, state fully what changes have taken place.

Pollutions—

1. Were there any fresh causes of river pollution introduced in your district in 1897 ?
2. Were any steps taken in 1897 to remove causes of pollution; and if so, were they attended with success ?

The Salmon Disease—

1. Has the salmon disease shown itself in your district this year? If so, when did it first make its appearance ? When was it at its height ? When did it disappear ?
2. What was the level of the river during the prevalence of the salmon disease ?
3. Can you state the number of diseased salmon taken from the river in each month, specifying what proportion was male and what female, what kelts, and what clean fish ?
4. Generally, have you any remarks or suggestions to make with regard to the salmon disease ?

The Spawning Season—

1. What was the earliest date, during the season of 1896-97, on which salmon were noticed spawning ?
2. Between what dates did the greatest number spawn ?
3. When did the spawning season finish ?
4. What was the level of the river during the spawning season ?
5. Were the numbers of spawning fish more or less than usual ?
6. Which are the principal spawning streams in your district ?

Kelts—

1. On what date, during last season, were kelts first noted migrating seawards ?
2. When did the chief migration take place ?
3. When was the river free from kelts ?
4. What was the level of the river during the period kelts were migrating ?

Smolts—

1. On which dates, during the year, were smolts noticed migrating ?
2. Was it a good smolt year ?

Artificial Propagation of Salmon—

Is there any hatchery in your district for the artificial propagation of salmon and trout, either belonging to the District Board or supported by private enterprise ? If so, describe its situation, and state how many fish can be hatched out in it annually.

Proportion of Male to Female Salmon—

Can you state the proportion of the male to the female salmon in your district or river, specifying whether your return, so far as it goes, is based upon an estimate or on actual enumeration ?

General Question—

Are there any other points relating to the salmon fisheries in your district to which you would wish to direct the attention of the Board, in addition to those suggested by the preceding queries ?

ANSWERS TO THE FOREGOING QUESTIONS.

THE DISTRICT OF THE RIVER FORTH.

No answers have been received.

THE DISTRICT OF THE RIVER TAY.

Take of Fish—
1. Below average in all waters.
2. No.
3. Clean salmon at all periods of the year.
4. Quite impossible.
5. (*a*) 57 lbs.; (*b*) 53 lbs.; (*c*) 53 lbs.

Protection—
1. £17,869 3s. 4d.
2. 8 per cent. = £1,429 10s. 6d.
3. Twenty.
4. Usual results for illegal fishing by nets, burning the water, cleeking, etc.; nearly all convicted.

Obstructions to the Passage of Fish—
1. No change.
2. No change.
3. Yes.
4. No.
5. No.
6. No.
7. No.

Pollutions—
1. The growth of population and works slightly increased.
2. Yes; by County Council at Aberfeldy. They are going to filter the refuse at Aberfeldy, also at Blairgowrie.

The Salmon Disease—
1. Early in November; at height about January; disappeared in June.
2. At all levels.
3. No.
4. I wish I could solve it.

The Spawning Season—
1. Towards end of October.
2. From 10th November till 10th December.
3. Chiefly over early in January.
4. Mostly nearly normal for season.
5. Below average.
6. Tay, Earn, Lyon, and Tummel

Kelts—
1. 7th November.
2. April and May.
3. June.
4. They go down the Tay at all levels; smaller streams require a flood to give water enough.

Smolts—
1. Late in March.
2. Considered above average.

Artificial Propagation of Salmon—
There is a salmon hatchery at Dupplin on Earn belonging to District Board. Hatches 570,000 ova.

Proportion of Male to Female Salmon—
Mere speculation; not one fisherman in a hundred can tell the difference between the male and female in a spring salmon until it is opened.

THE DISTRICT OF THE RIVER SOUTH ESK.

Take of Fish—
1. Below the average in all cases.
2. No; have no means of getting this information.
3. (*a*) 16th February; (*b*) July and August; (*c*) July and August.
4. Impossible for us to supply this information.
5. (*a*) and (*b*) 48 lbs.; (*c*) 30 lbs.

Protection—
1. £3,507.
2. Ten per cent. on rental.
3. Nine.
4. Yes; six prosecutions. Chiefly for dragging and illegal use of instruments in catching salmon. One case, for breach of weekly regulations, raised against tenants of fishings, found not proven as against tenants, by Sheriff Campbell Smith, but on appeal to High Court, reversed. Tenants found proper parties to be prosecuted under 24th Sec. of 1868 Act. Convictions obtained in all the other cases.

Obstructions to the Passage of Fish—
1. No dams destroyed or given up, and no new dams or old dams altered.
2. No cruives fished in 1897.
3. Dams generally worked in accordance with bye-laws. Some improvements about to be made in some of dams. Only cruives in district are at Brechin Castle, but have been closed for some years under certain conditions stated in an agreement between town of Brechin and their tenants of mills and Earl of Dalhousie.
4. No.
5. Fairly good passage.
6. No.
7. Ascent of fish to upper waters improved in consequence of an agreement between Earl of Southesk and proprietor of dam and upper proprietors, whereby netting of river on fishings has been stopped for period of years.

Pollutions.
1. No.
2. No.

The Salmon Disease—
1. Yes; first observed 15th April; at height about middle of May; scarcely disappeared.
2. Fair ordinary size.
3. From 15th April to 15th May 21 clean salmon taken out of river—12 males, 9 females; also 65 kelts—35 males, 27 females.
4. No.

The Spawning Season—
1. 18th November, 1896.
2. November and December, 1896.
3. 14th January, 1897.
4. Eight inches above normal size.
5. Less.
6. Kinnaird, Finavon, Tannadice, Craigessie, and all above.

Kelts—
1. 5th March.
2. Between 23rd March and 14th April.
3. 14th June.
4. About 2 feet above usual size.

Smolts—
1. From 31st May until 5th July.
2. Yes.

Artificial Propagation of Salmon—
None.

Proportion of Male to Female Salmon—
About equal.

General Question—
Nothing occurs worthy of mention.

THE DISTRICT OF THE RIVER NORTH ESK.

Take of Fish—
1. (*a*), (*b*), (*c*) and (*d*) All below the average.
2. (*a*), (*b*) and (*c*) No.
3. (*a*) 16th February ; (*b*) and (*c*) June and July.
4. (*a*) and (*b*) Cannot give statistics of percentage.
5. (*a*) 26 lbs.; (*b*) 38 lbs.; (*c*) 38½ lbs. Salmon.

Protection—
1. £6,579.
2. £477.
3. Thirteen bailiffs and one superintendent.
4. One ; fishing with net during annual close time for nets. Convicted.

Obstructions to the Passage of Fish—
1. None.
2. No cruives.
3. The Craigo Dam is not worked in accordance with the provisions of the Bye Laws, one member dissenting.
4. None.
5. The Craigo Pass not at all times.
6. No.
7. None.

Pollutions—
1. None.
2. No.

The Salmon Disease—
1. September. Diseased fish are occasionally found in the river throughout the season.
2. Ordinary level.

3. About 507 during the year :—

	Male.	Female.	Total.
Salmon—Spawned, . .	231	117	348
„ Unspawned, .	19	7	26
Grilse—Spawned, . .	43	42	85
Trout „ . .	—	—	48
			507

4. No.

The Spawning Season—
1. 10th November.
2. 15th November to 30th December.
3. 15th January.
4. About an average.
5. About an average.
6. Gannochy, King's Ford, Pert Ford, Stob Ford, Bothy Stream, Peter's Stream, Bailie Middleton's Stream, Broad Rack, and Bridge Streams.

Kelts—
1. March.
2. April.
3. About end of May.
4. Half-flood and floods.

Smolts—
1. April and May.
2. Very good.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
Estimate two-thirds males and one-third females.

THE DISTRICT OF THE RIVER BERVIE.

Take of Fish—
1. (*a*), (*b*), (*c*) and (*d*) Below average.
2. (*a*), (*b*) and (*c*) No.
3. (*a*) 25th February ; (*b*) August ; (*c*) July.
4. (*a*) and (*b*) Cannot.
5. (*b*) About 40 lbs. salmon.

Protection—
1. £870 13s.
2. £156 14s.
3. Six.
4. One prosecution for breach of weekly close time. Convicted.

Obstructions to the Passage of Fish—
1. None.
2. No cruives.
4. No.
5. When river in flood.
6 and 7. No.

The Salmon Disease—
No appearance of disease.

The Spawning Season—
1. November.
2. November to end of December.
3. About the end of December.
4. Ordinary level.
5. Less.
6. The main river.

Kelts—
1. About the first week of January.
2. February.
3. March.
4. Ordinary level.

Smolts—
1. May and June.
2. Bad.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
Estimate about two males to one female.

THB DISTRICT OF THE RIVER DEE (ABERDEENSHIRE).

Take of Fish—
1. Below the average in each of these four cases.
2. No.
3. (*a*) 11th February; (*b*) April was the best month of the season, the grilse season having been poor; (*c*) Grilse began to run on 10th April —sea-trouts on 11th February.
4. No information on these points.
5. (*a*) 39 lbs.; (*b*) 45 lbs.; (*c*) 34 lbs.

Protection—
1. £16,176 5s. 10d.
2. Six per cent. on above assessable rental.
3. Twenty-one.
4. Three prosecutions, implicating 6 men. For having unseasonable salmon or poaching implements in their possession. Four of the 6 persons implicated convicted, and fined £2 each with expenses. As regards the other two persons, case compromised before trial by a payment of £2 10s. each.

Obstructions to the Passage of Fish—
1. No dams.
2. No cruives.
3. Does not apply to Dee District.
4. No.
5. No passes.
6. No.
7. None.

Pollutions—

1 and 2. The Town Council of Aberdeen are at present constructing large sewers in the Reclaimed Land, Aberdeen, with combined outfall into the river, by which, if their scheme were to be carried out, the sewerage of extensive and rapidly growing districts of the city would be drained into the Lower Dee, where it is a tidal river. The District Board and the individual proprietors of fishings having objected to the proposed works and intimated their intention of taking proceedings to prevent same from being carried out, negotiations have been and are at present going on, under which it is hoped an amicable and satisfactory arrangement will be come to, whereby injury to the river or fishings will be avoided.

The Salmon Disease—

1. Very little appearance of disease. Some diseased fish seen early in November but disappeared at end of same month when river got larger.
2. Low.
3. Only one or two fish taken out and destroyed in November; no record kept whether male or female; no clean fish but kelts.
4. No.

The Spawning Season—

1. 17th October.
2. Upper river between 17th October and middle of November. Lower river between end of November and end of January.
3. Practically at the end of January.
4. Low at chief spawning time in upper river, but at the best spawning time in the lower reaches flooded.
5. Upper waters less than usual; lower water more than usual.
6. Upper river itself and tributaries of Feugh, Gairn, Muick, Clunie, and Geldie.

Kelts—

1. Always a few after end of December.
2. In the month of April.
3. Never quite free, but most free in month of July.
4. Rather low.

Smolts—

1. Early in April.
2. Fairly so.

Artificial Propagation of Salmon—

Board has constructed and maintains a hatchery at Drum, about 11 miles up the river. 1,200,000 ova put into the hatchery boxes in 1897, 93½ per cent. of which were successfully hatched and put into the river.

Proportion of Male to Female Salmon—

No information on this point.

General Question—

No.

THE DISTRICT OF THE RIVER DON.

Take of Fish—

1. Below the average in each of these four cases.
2. No
3. (*a*) 11th February; (*b*) end of July and first days of August; (*c*) first grilse caught 20th April, but a poor grilse season; sea trout 11th February and throughout season.
4. No information on these points.
5. (*a*) 38½ lbs.; (*b*) 39 lbs.; (*c*) 49½ lbs.

Protection—

1. £3,383 4s. 5d.
2. 20 per cent. on the assessable rental.
3. Twenty.
4. Fourteen prosecutions implicating 22 individuals. The offences were for having unseasonable salmon in their possession or poaching implements. All convicted, save in one case found "not proven." Fined £2 to £5, with option of imprisonment for periods of from 7 to 30 days. Only one or two paid fine and expenses; the others went to prison.

Obstructions to the Passage of Fish—

1. No dams destroyed or given up, nor have any new dams been built or old dams altered.
2. No.
3. Yes.
4. No.
5. Fish can always ascend when river is high; but when low there are places on the lower river where, owing to mills and weirs, ascent is impossible.
6. No.
7. No changes.

Pollutions—

1. No fresh causes of pollution were introduced in 1897.
2. Negotiations between the Board, the Aberdeen District Committee of the County Council, and the owners of mills adjoining the river, were carried on for some considerable time with the view of disposing otherwise of the sewage and mill refuse presently drained into the river, but these have now fallen through and the Boards are taking steps otherwise to obtain the removal of the causes of pollution.

The Salmon Disease—

1. A good deal of disease was apparent from October to December caused from fish being confined in large numbers in polluted water behind mill dykes. Now that the river is higher it has practically disappeared.
2. Very low.
3. 145 diseased salmon taken from the river and destroyed between beginning of October and middle of December; mostly female fish; only 1 kelt.
4. It is believed that the salmon disease in the Don was due to impurities from mills, and especially to the abstraction of water by these mills, occasionally making long stretches of the bed of the river almost dry, thus causing the fish to congregate in hundreds in the deeper pools below, where they soon show signs of disease. But for these causes it is thought that there would have been little or no disease.

The Spawning Season—

1. 5th November.
2. Between the middle and end of December.
3. Practically finished at end of December.
4. Rather above average height.
5. Less.
6. Chiefly in the river itself; best places at Alford 27 miles up and at Kildrummy 37 miles.

Kelts—

1. Always a few.
2. Greatest number in May and June.
3. Never quite free but mostly so in July.
4. Small.

Smolts—

1. Middle of April.
2. Fairly so.

Artificial Propagation of Salmon—

A small hatchery at Fish Street, Aberdeen, in the premises of the Aberdeen Salmon Company, capable of receiving from 50,000 to 60,000 ova. Ova actually put in, season 1897 was 45,000, of which 38,000 hatched, and put half into the Dee and half into the Don from 10 to 18 miles above Aberdeen.

Proportion of Male to Female Salmon—

No information on these points.

General Question—

No.

THE DISTRICT OF THE RIVER YTHAN.

Take of Fish—

1. Below the average.
2. (*a*) and (*b*) Information cannot be obtained ; (*c*) about 200 salmon.
3. (*a*) On 25th February; (*b*) By rod and line in the autumn ; (*c*) August.
4. (*a*) and (*b*) Information cannot be obtained.
5. (*a*) Information cannot be obtained ; (*b*) salmon 39 lbs. ; (*c*) salmon 27 lbs.

Protection—

1. £1,293 10s.
2. 2s. 1½d. per £.
3. One all the year round, and four others from October to April.
4. One—for being in possession of unclean fish; convicted, with £1 11s. 9d. of fine and expenses.

Obstructions to the Passage of Fish—

1. None.
2. There are no cruives.
3. Yes.
4. No.
5. Yes, at all times.
6. No.
7. Nothing.

Pollutions—

1. No.
2. No.

The Salmon Disease—

1. Yes ; first seen 25th December 1896; at height in March 1897; disappeared in May 1897.
2. Above the average level.
3.

Month.	No. of Fish.	Males.	Females.	Weight.	Diseased.	Not Diseased.	Salmon.	Sea Trout.	Spawned.	Unspawned.
1896. December	1	1	..	Lbs. 7	1	..	1	..	1	..
1897. January .	17	14	3	152	17	..	17	..	17	..
February .	8	8	..	53	8	..	8	..	8	..
March . .	26	20	6	245	25	1	26	..	24	2
April . .	9	8	1	105	9	..	9	..	9	..
Total, .	61	51	10	562	60	1	61	..	59	2

4. No.

The Spawning Season—
1. First week of November 1896.
2. From 15th to 31st December 1896.
3. About the middle of February 1897.
4. In heavy flood at first and low the latter part.
5. Less.
6. Ythan, Bronie Burn, Ebrie Burn, Little Water, Fordoun Burn.

Kelts—
1 and 2. Not observed.
3. End of May.
4. Not observed.

Smolts—
1. May 14th.
2. Yes.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
Estimated at 5 male to 4 female.

General Question—
No.

THE DISTRICT OF THE RIVER UGIE.

Take of Fish—
1. (*a*) About the average; (*b*) about the average; (*c*) below the average; (*d*) below the average.
2. The number of fish caught approximately is as follows :—(*a*) About 700 sea trout; (*b*) about 2,500 salmon and grilse ; (*c*) about 70 salmon and grilse, and 500 sea trout.
3. (*a*) March 4th ; (*b*) August and September ; (*c*) August, September, and October.
4. The salmon fishings are still in the hands of private enterprise, and the tacksmen decline to give the information or keep records.
5. (*a*) 9 lbs. (sea trout ; (*b*) 39 lbs. (salmon) ; (*c*) 28½ lbs. (salmon).

Protection—
1. £504 10s.
2. 1s. 1·24d. per £.
3. Five.
4. There were no prosecutions last year (1897).

Obstructions to the Passage of Fish—
1. There have been no dams destroyed, given up, or altered in any way during the year 1897.
2 and 3. None of the dams or cruives in this district have been worked during the year 1897.
4. None.
5. The dams at Englishmill and Ravenscraig afford a free passage at all times. The dams higher up the river afford passage only when the river is at least half-flood.
6. None that I know of.
7. No.

Pollutions—

1 and 2. It has been suspected for some time that a burn flowing into the Ugie was being polluted by deleterious matter running into it near the village of New Maud from a sheep-dip near at hand. The pollution became more noticeable in the month of November last, and the matter was brought before the District Board. Instructions were given to the water bailiff to keep a close watch, with the result that the pollution was traced to the sheep-dip. Steps were immediately taken to have it stopped, and that has now been done. There have been no other causes of pollution.

The Salmon Disease—

There has been no disease this year (1897).

The Spawning Season—

1. November 17th 1896.
2. Between December 1st and 20th 1896.
3. About the end of December 1896.
4. Half-flood.
5. More than usual.
6. Stonemill, Buthlaw, and North Ugie.

Kelts—

1. On February 25th.
2. In March.
3. At the end of May.
4. Mostly half-flood.

Smolts—

1. Between the middle of April and the middle of May.
2. An average year.

Artificial Propagation of Salmon—

There is a small hatchery, but it has been abandoned, and there are no means in use for the artificial propagation of salmon and trout.

Proportion of Male to Female Salmon—

It is estimated that the proportion is about 5 males to 3 females, but there is no reliable estimate.

General Questions—

None.

THE DISTRICT OF THE RIVER DEVERON.

Take of Fish—

1. (*d*) Below the average.
2. No.
3. (*a*) 11th February; (*b*) In fresh water—February and March ; in the sea —July and August ; (*c*) July and August.
5. (*a*) 32 lbs.; (*b*) 42 lbs.; (*c*) 32 lbs.

Protection—

1. £2,658 4s. 5d.
2. 2s. 4d. per £.
3. Nine.
4. Two persons have been fined for poaching, and another prosecution is pending.

The Salmon Disease—
1. There was very little appearance of disease.
3.

Sex.	November.	December.	January.	February.	March.	April.
Males, .	17	57	40	26	10	1
Females,	4	10	19	20	31	8
Total, .	21	67	59	46	41	9

The Spawning Season—
1. 19th October.
2. 1st November and 1st January.
3. 1st March.
4. High.
5. About the average.
6. Well distributed over the whole river.

Kelts—
1. 28th November.
2. In April.
3. 22nd May.
4. Half-flood.

Smolts—
1. 11th and 20th May.
2. Fair.

Artificial Propagation of Salmon—
Yes. One in policies of Duff House, supported by private enterprise, in which about 150,000 could be hatched yearly.

Proportion of Male to Female Salmon—
No

General Question—
Negotiations have been concluded for the removal of the cruive dyke, and operations will commence about the 14th of January next.

THE DISTRICT OF THE RIVER SPEY.

Take of Fish—
1. Below average throughout the district.
2. No.
3. (*a*) 11th February; (*c*) grilse, first appearance in May, and continue until August; sea-trout all over the season.
5. (*a*) Salmon, 47 lbs.; (*c*) salmon, 53 lbs.

Protection—
1. £9,637 15s.
2. 2s. 4d. per £, realising £1,124 8s. 1d.
3. One superintendent, one inspector, eight sergeants, and thirty-five constables.
4. See Superintendent's Report (copy of which herewith sent).

Obstructions to the Passage of Fish—

1 See Report.
2. No.
3. As far as possible.
4. No.
5. Yes, when size of stream suits in volume.
7. A cut or passage at the mouth of the Spey has been re-opened to admit of easier access to and from sea.

Pollutions—

1. Erection of new distilleries and increase of size of old ones. Amount of pollution coming down river largely increased.
2. Court of Session litigation pending, Seafield and others v. Kemp; also action against Benrinnes Distillery Company pending.

The Salmon Disease—
See Report.

The Spawning Season—
1, 2, 3, 4, 5, and 6—See Report.

Kelts—

1. 18th December.
2. November, December, January, and February.
3. July till September.
4. Various

Smolts—
See Report.

Artificial Propagation of Salmon—
See Report.

Proportion of Male to Female Salmon—
See Report.

The following is a copy of the Superintendent's Annual Report for the year ending 26th August 1897, submitted to the Meeting of the Spey District Board held at Elgin on 22nd October, 1897 :—

I.—*Salmon Spawning.*

The following Table shows the dates of the first appearance of Salmon Spawning Beds, and the number seen by bailiffs during the last three spawning seasons on the following named streams or tributaries :—

1894.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich - - -	29th September	1008
Avon - - -	10th October	1316
Livet - - -	12th ,,	1735
Conglass - - -	12th ,,	445
Lochy - - -	24th ,,	115
Dulnain - - -	13th ,,	638
Nethy - - -	19th ,,	435
Druie - - -	13th ,,	430
Feshie - - -	15th ,,	767
Tromie - - -	18th ,,	204
Truim - - -	15th ,,	76
Spey (above Laggan, Badenoch)	12th ,,	45
Total, - - -		7214 Spawning Beds.

1895.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich	1st October	715
Avon	15th ,,	1550
Livet	16th ,,	1300
Conglass	14th ,,	273
Lochy	14th ,,	90
Dulnain	15th ,,	420
Nethy	11th ,,	429
Druie	15th ,,	153
Feshie	14th ,,	812
Tromie	16th ,,	158
Truim	17th ,,	159
Spey (above Laggan, Badenoch)	15th ,,	144
	Total,	6203 Spawning Beds.

1896.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich	6th October	292
Avon	10th ,,	754
Livet	14th ,,	773
Conglass	14th ,,	189
Lochy	22nd ,,	74
Dulnain	13th ,,	868
Nethy	15th ,,	418
Druie	13th ,,	215
Feshie	12th ,,	636
Tromie	17th ,,	210
Truim	14th ,,	198
Spey (above Laggan, Badenoch)	10th ,,	151
	Total,	4778 Spawning Beds

TABLE OF TEN YEARS' SPAWNING BEDS.

Total number of Beds for year	1887	3,849
Do. do.	1888	5,637
Do. do.	1889	2,932
Do. do.	1890	2,768
Do. do.	1891	4,591
Do. do.	1892	5,287
Do. do.	1893	4,635
Do. do.	1894	7,214
Do. do.	1895	6,203
Do. do.	1896	4,778

The decrease in spawning beds for last year when compared with the previous year is 1,425 beds. The falling-off in spawning took place on the Fiddich and the Avon and Avon tributaries. On the Fiddich the deficiency compared with previous year was 423 beds, while upon the Avon and its tributaries the decrease was 1,423 spawning beds, giving a total over the two tributaries of 1,846 beds. The foregoing figures, however, show that 421 beds of an increase for last season had been counted upon the tributaries of Spey above Grantown. During the spring and summer of 1896 salmon were plentiful in the River Spey and sea coast. The grilse season for same season was poor. The salmon fell off towards autumn, and did not run in the river again to any extent until November and December. The fish that ran up the river during the last two mentioned months were numerous, but these spawned on River Spey, principally between the two points of Boat o' Brig and Grantown. This last-mentioned run of fish did not seek into the Fiddich, in my idea, for the following reasons:—In the first place, on account of the still existing presence of distillery pollution in this stream, where deposited ova, especially in the vicinity of Dufftown, would from this evil be rendered useless. It is also very doubtful whether fry hatched in the river above Dufftown do not suffer injury or die as soon as they drop down below the distilleries. Secondly, on account of the presently existing "bad draw" for ascending fish at mouth of stream. At the junction of Fiddich with Spey during the last year or two an accumulation of beach or shingle has lodged on the left or Dandaleith side of the river from the railway bridge downwards, until below where Fiddich mouth enters, and this beach has had the effect of throwing a heavy stream right into the mouth of the Fiddich, or in other words, "drowning the draw of Fiddich," by causing the natural run for ascending fish upon Spey at this point to be upon the easy or Dandaleith side of the river, and they are thus led past Fiddich mouth. Formerly, or previous to this alteration at Fiddich mouth, large numbers of salmon about to spawn found their way into this stream during the months of November, December, and January. Avon and its tributaries depend most upon autumn—September and October—run fish for the middle and lower reaches, and, as I have already said, the run of fish fell off during those two months last year. The upper Spey tributaries beyond Grantown depend most upon summer run fish, and as already noted, this run of fish was exceptionally good.

The late Mr. Wedderspoon asked me last October to get the Bailiffs to count the spawning beds formed and wrought upon on River Spey between Boat o' Brig and Carron. The Spey during spawning season, in respect of its normal flow for a considerable length of time at this season, gave the men a favourable opportunity of counting the beds over this district, and their respective records were as follows:—On Aberlour section, from Carron to Tunnel Pool, 50 beds; Craigellachie section, from Tunnel Pool to Bulwark, 153 beds; Rothes district, from Bulwark to Hollybush, 563 beds; Boat o' Brig section, Hollybush to Boat o' Brig, 476 beds; upon Burn of Mulben, 21 beds—total, 1,263 spawning beds. Regarding the weather during the spawning season, the absence of high spates and severe frosts was in favour of successful hatching results to the deposited ova. Nothing was observed among the spawning fish over the tributaries in the way of unevenly matched sexes, such as more males than females or *vice-versa*.

During the last 25 years the mouth of the River Spey has gradually diverged to the extent of nearly a mile westward—that is, from a point of the sea beach near the Tugnet premises to west of the village of Kingston. Along the said mile the river runs almost westward, and the only barrier preventing its running direct into the sea is a wall of shingle about 180 feet wide and 10 to 12 feet deep. I consider that if the Spey Board gave their attention to and agreed to have this wall or barrier cut at a point 200 or 300 yards west from Tugnet, and thus allow the river to run "slap-dash" into the sea, that a free and fast run of salmon up the river would be the result. The present state of matters at the mouth of the river is certainly a serious barrier to a free run of fish up the river at all times, including the weekly "slap." At present the river enters the sea on a dead level or still running state, thus giving no force of fresh water over the bar to entice fish seeking for same to enter the river. A cut to make the new run as proposed could be carried out for £200.

II.—*Smolt Season.*

During the spring and early summer months of the present year the appearance of descending smolts on the River Spey was, like last year, exceptionally good. As usual, during present year, from 26th April to 5th June—six weeks—eight bailiffs were on duty protecting smolts and salmon fry over the River Spey and tributaries, viz., one at Speymouth, one at Rothes, one at Dufftown, one at Aberlour, one at Ballindalloch, one on Upper Avon and Livet, one at Grantown, and one at Duthil. Twenty-three dozen (instead of twelve dozen as formerly) of printed notices cautioning persons against killing smolts and parr were posted up over all the district. Trout anglers met with by the bailiffs were civil, and willing to show the contents of their baskets when asked to do so. The usual force of bailiffs to protect parr went on duty again at the 1st of August.

III.—*Disease among Fish.*

The fish disease statistics for season 1896-97 were, as usual, noted upon the Fiddich. During the last seven years I gave in my annual report the yearly percentage of fish dying from fungoid disease upon Fiddich during each spawning season, calculating the percentage of dead fish to the number of spawning beds counted on the stream during the season. It should, however, be noted that as it takes two fish to form a spawning bed, the actual death-rate among the spawning fish is only one-half of that given in my percentages. During the seven seasons the average death-rate, calculated as above stated, was practically 15 per cent. During last season the number of spawning beds counted upon Fiddich was 292, and the number of dead or dying fish removed was 21, or somewhat over 7 per cent. The previous seven years showed percentages varying from 21 down to 8. The returns handed in by bailiffs as to burying of dead or dying fish during last season were as follows:—December 4th, 1 male salmon; 2nd January, 3 male grilse; 9th January, 1 male grilse and 2 male salmon; 16th January, 2 male grilse and 4 male salmon; 23rd January, 2 male grilse; 18th February, 1 male sea trout; 6th March, 2 male salmon; 20th March, 1 male grilse and 1 male salmon; 27th March, 1 male grilse—total 21, all of which were males, and all were spawned.

IV.—*Poaching during the Year.*

During the year one case of salmon poaching committed during the annual close time was tried before the Sheriff Court at Banff. The accused was convicted, and sentenced to pay a fine of £1, with £2 2s. of expenses, or suffer 7 days' imprisonment. Other three cases, involving three persons, in which the accused while angling during the open time were found by the bailiffs to be in possession of parr or salmon fry, were disposed of by having each of the three accused brought before a J.P. and admonished.

V.—*Bye-Laws.*

The Bye-Laws relating to dam dykes, mill lades, sluices, hecks, etc., were carried out or attended to fairly well by the respective owners of same over all the district during the season. The old meal mill dam dyke on Dullan at Pittyvaich, Dufftown—the mill is now replaced by a distillery—was during last autumn reconstructed, and a more improved fish pass built by the Distillery Company.

General Remarks.

The river and sea coast net salmon fishing opened on 11th February, and closed again for the season upon the 26th August. The carrying out of the weekly close time over the district during the season was regularly inspected by the Superintendent, the Inspector, and Bailiff John M'Donald. The observance given to the carrying out of the requirements anent the "weekly slap" were regular and sincere on the part of the fishermen and those responsible, thus giving no grounds for complaint or notification of infringement being made or reported to the Board.

Another half million of salmon fry, successfully hatched at His Grace the Duke of Richmond and Gordon's hatchery at Fochabers, were during early summer put into the river in a strong, healthy state, and at a stage when liberty in their natural element should be the best or most essential factor during their fry gradational age. I visited the hatchery twice during the time that the fry were to be seen therein, and the sight of so many living masses of salmon fry was well worth going a long way to see. This extensive hatchery was erected and filled in the autumn of 1892 (a small or temporary one, also belonging to His Grace, having been in previous use for some two seasons nearer the mouth of the river), consequently the last liberated fry were the fifth lot turned out of the Fochabers hatchery. Mr. Thomas Rae, overseer of fishings at Tugnet, who has the management of this hatchery, informs me that it is meantime proposed to considerably enlarge the hatchery.

The full force of bailiffs or Spey police is constituted as follows:—The superintendent, residing at Aberlour; the inspector, stationed at Grantown; eight sergeants, and thirty-seven constables.

GEORGE K. MACGREGOR, *Superintendent.*

THE DISTRICT OF THE RIVER FINDHORN.

Take of Fish—

1. (*a*) Below average; (*b*) below average; (*c*) below average; (*d*) below average.
2. (*a*), (*b*), and (*c*) No.
3. (*a*) 11th February; (*b*) April and May; (*c*) May, June and July.
4. (*a*) and (*b*) Cannot say.
5. (*a*) Salmon 36 lbs.; trout 4 lbs; (*b*) Salmon 45 lbs.; (*c*) Salmon 21 lbs.

Protection—

1. £3436.
2. £345.
3. Eighteen water bailiffs.
4. No.

Obstructions to the Passage of Fish—

1. No dams in the district.
2. No cruives in the district.
3. No dams or cruives.

4 and 5. No passes.
6 and 7. No.

Pollutions—

1. No.
2. No pollution.

The Salmon Disease—

1. No disease in the district.
2. No disease.
3. No diseased salmon.
4. No.

The Spawning Season—

1. Upper district, 18th October; lower district, 19th November.
2. Upper district, between 26th October and 26th November; lower district, December and January.
3. Upper district, 30th November; lower district, end of January.
4. Upper district very low; lower district high.
5. About an average.
6. Upper district between Drynachan and Coignafearn; lower between Waterford and Sluie.

Kelts—

1. Kelts begin to migrate seawards immediately after the spawning season is over.
2. January and beginning of February.
3. May generally.
5. Sometimes flood, half-flood, and low.

Smolts—

1. From the middle of March till the end of May.
2. Very good.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
Cannot say.

General Question—
No.

THE DISTRICT OF THE RIVER NAIRN.

No answers have been received.

THE DISTRICT OF THE RIVER NESS.

Take of Fish—
1. (*a*), (*b*) and (*c*) average.
2. About 33,000.
3. (*a*) 11th February; (*b*) February; (*c*) June, July, and August.
4. Information cannot be obtained.
5. Salmon, 42 lbs.

Protection—
1. £3488.
2. 1s. 9d. per £.
3. Four permanent; three temporary.
4. None.

Obstructions to the Passage of Fish—
1 and 2. None.
3. Yes.
4. No.
5. One fish pass does not afford a free passage for salmon ascending when the river is in a low state.
6. No.
7. Nothing been done.

Pollutions—
1. No.

The Salmon Disease—
1. Not this year.

The Spawning Season—
1. End of October.
2. November and January.
3. End of January.
4. Can't say.
5. About the average.
6. Ness, Garry, Oich, Morrison, Enrich, Quoich.

Kelts—
1. 11th February.
2. March and April.
3. Middle of May.
4. Can't say.

Smolts—
1. April.
2. Average.

Artificial Propagation of Salmon—
There is a private hatchery at Glenquoich, supported by Lord Burton. No salmon are hatched in it.

Proportion of Male to Female Salmon—
In the month of December there are four males to one female.

THE DISTRICT OF THE RIVER ALNESS.

Take of Fish—

1. (*a*) Slightly below the average; (*b*) considerably below the average; (*c*) no fixed engines in district; (*d*) below the average throughout the district.
2. Cannot supply this information.
3. (*a*) About 20th February; (*b*) about middle of July; (*c*) from middle of June to end of August.
4. Cannot supply this information.
5. (*a*) About 30 lbs.; (*c*) about 16 lbs.

Protection—

1. £607 10s.
2. 6s. per £.
3. One permanent inspector and four temporary bailiffs.
4. None.

Obstructions to the Passage of Fish—

1. None.
2. No cruives fished in District.
3. Yes; in Alness River.
4. No.
5. Yes; at all times.

6 and 7. No.

Pollutions—

1. No.
2. No pollution in river.

The Salmon Disease—

No salmon disease in district.

The Spawning Season—

1. About 25th October.
2. Between 1st and 12th November.
3. About 25th December.
4. First half very low; end of season in flood.
5. Much less than usual.
6. Upper reaches of Alness River.

Kelts—

1. March.
2. April.
3. June.
4. About half-flood.

Smolts—

1. From 20th April to 19th June.
2. Fair.

Artificial Propagation of Salmon—

The Board have a hatchery capable of hatching over 100,000 fish. It is situated in the lower reaches of the river. There is also a private hatchery capable of hatching 80,000 fish.

Proportion of Male to Female Salmon—

Can't state the proportion; but it was noticed that there were more males than females on the spawning beds. In the month of October there were more females landed by the rod than males.

General Question—

The District Board would again direct the attention of the Fishery Board to the destruction of fish occasioned by the illegal mode of fishing pursued in the Cromarty Firth, and to which reference is made in the Appendix to the *Fourteenth Annual Report of the Fishery Board* (see Part II., p. 52).

THE DISTRICT OF THE RIVER CONON.

Take of Fish—

1. (*a*) and (*b*) Salmon and grilse below the average; (*c*) at three of the fishing stations about the average; at the four remaining stations below the average; (*d*) below the average.
3. (*a*) On the opening day of the fishing, 11th February; (*b*) June and July; (*c*) grilse ran from the beginning of May to the close of the fishing. The main run of sea-trout is in March and April. Clean sea-trout in tidal waters of Conon at all seasons.
5. (*a*) Several were caught weighing from 18 lbs. to 22 lbs.; (*b*) about 26 lbs.; (*c*) about 20 lbs.

Protection—

1. 1896-7, £2590.
2. 1s. 4d. per £.
3. One permanent inspector and four temporary bailiffs.
4. Yes; against a crew of fishermen from Cromarty for fishing with a small-meshed sweep-net and killing fish of the salmon kind. Conviction obtained, and the crew fined 10s. each, with £1 of expenses, or 7 days' imprisonment.

Obstructions to the Passage of Fish—

2. The cruives in this district have not been fished in 1897.
3. There is one dam in this district; it is not worked in accordance with the bye-law, Schedule G. There are two cruives in this district; they are worked in accordance with the bye-law, Schedule F, regulating the same.
5. Yes; at all times.
7. The Brahan net and cruive fishing have not been worked during the last eight seasons, whereby large numbers of salmon and grilse have ascended to the angling waters.

The Spawning Season—

1. About the 6th October.
2. Between the 5th and 15th November.
3. About the middle of December.
4. From the middle of October to the 15th November the river was down to summer level, and during the rest of the spawning season the river was in heavy flood.
5. I noticed that there was a decrease of spawning salmon in the lower spawning grounds of the Conon, Blackwater, and Orrin; but in the upper spawning grounds of the Conon, and on all the spawning grounds of the Meig, the number of salmon on the spawning beds was fully up to the average of the last eight spawning seasons.
6. There are good spawning grounds in the River Conon from the tidal waters, and in the tributaries Blackwater, Orrin, and Meig.

Kelts—

1. In the beginning of March.
2. From the last week of March to the end of April.
3. About the end of May.
4. Flood, half-flood, and low.

Smolts—

1. March, April, May, and June
2. Yes; fairly good.

Artificial Propagation of Salmon—

There is a salmon hatchery at Conon Bridge. It partly belongs to Colonel M'Kenzie of Seaforth, and partly to the District Board. Last season I hatched a number of ova taken from the River Brora in exchange for a like number taken from the River Conon, and the fry, when seven weeks old, I transferred to the lower reaches of the Conon.

THE DISTRICT OF THE KYLE OF SUTHERLAND.

Take of Fish—
1. Much below the average.
2. The number caught at Bonar Bridge was 7407, and about 10,009 in all—excluding fish caught by rod.
3. (*a*) On 11th February; (*b*) April, May, and June; (*c*) June and July; very few sea-trout.
4. Unable to furnish any information.
5. One salmon 35 lbs.; (*a*) by net and coble.

Protection—
1. £2731.
2. 1s. 9d. per £=£238 19s. 3d.
3. There are 16 water bailiffs.
4. No.

Obstructions to the Passage of Fish—
1. None.
2. No.
3. As far as possible.
4. No.
5. When there is sufficient water, and when the rivers are in flood.
6. Yes; at Glenmuick Falls.
7. All the fisheries at Bonar Bridge were worked only for five days a week during last season, and during the latter part of the season they were fished only for 60 hours a week.

Pollutions—
1 and 2. No.

The Salmon Disease—
1. No.

The Spawning Season—
1. 20th September.
2. Between 15th October and the end of November.
3. 20th December.
4. Very low.
5. More than usual.

Kelts—
1. No record.
2. In January and February.
3. In April.
4. Occasionally in flood.

Smolts—
1. 1st April.
2. No.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

SUTHERLAND, EAST COAST DISTRICT.

Take of Fish—

1. (*a*) Below; (*b*) much below, with the exception of the River Brora, where it has been slightly over the average; (*c*) below; (*d*) below.
2. (*a*) Helmsdale—351 salmon, 469 grilse, and 72 trout; Brora—871 salmon, 238 grilse, and 127 trout; Fleet—20 salmon. (*b*) 2709 salmon, 4778 grilse, 627 trout. (*c*) Helmsdale—507 fish; Brora—about 300.
3. (*a*) January 11th; (*b*) June; (*c*) June and July.
4. (*a*) March, salmon 15·01 per cent.; April, salmon 25·28 per cent.; May, salmon 20·94 per cent.; grilse 4·94 per cent.; June, salmon 24·5, grilse 38·06 per cent.; July, salmon 14·4 per cent., and grilse 55·7 per cent.; August, grilse ·01 per cent. (*b*) February, salmon ·07 per cent.; March, salmon 1·1 per cent.; April, 14·6 per cent. salmon; May, salmon 36·13 per cent., grilse 2·7 per cent.; June, salmon 23·5 per cent., grilse 22·9 per cent.; July, salmon 18·2, grilse 61·6 per cent.; August, salmon 6·4 per cent., grilse 13 per cent.
5. (*a*) 31 lbs.; (*b*) 40 lbs.; (*c*) 29 lbs.

Protection—

1. £1855. (Helmsdale angling let with shootings, and £600 apportioned for angling rent; but the angling let separately from the shootings would let at a much higher figure.)
2. None.
3. Four. All keepers bound to assist in watching rivers.
4. No.

Obstructions to the Passage of Fish—

2. There are no cruives.
4. No.
5. Yes.

6 and 7. No.

Pollutions—

1. None.
2. No.

The Salmon Disease—

1. Very slight; noticed first in August; still appearance of the disease on the Fleet.
2. Low.
3. Not more than a dozen altogether this year.
4. No.

The Spawning Season—

1. 10th to 12th October.
2. 20th to 30th October.
3. The end of November.
4. Various, but generally low.
5. Considerably less.
6. Brora, Helmsdale, Fleet, and their several tributaries.

Kelts—

1. 11th March.
2. End of March to end of April
3. End of May.
4. Low.

Smolts—

1. May and June.
2. Yes.

Artificial Propagation of Salmon—
There is a small hatchery on the Brora, but it is chiefly used for hatching Loch Leven trout.

Proportion of Male to Female Salmon—
No reliable statistics, but the proportion of males generally found to be the larger. When netting for ova the proportion has often been found to be five males to one female.

General Question—
No.

SUTHERLAND, NORTH COAST DISTRICT.

Take of Fish—
1. (*a*) and (*b*) Below the average; (*c*) and (*d*) about the average.
2. (*a*) and (*b*) Salmon, 2,184; grilse, 8,138; trout, 206; cannot separate; (*c*) about 750, no certainty.
3. (*a*) February; (*b*) May; (*c*) May to August.
4. No information.
5. (*a*) 23 lbs.; (*b*) 38 lbs.; (*c*) 27 lbs.

Protection—
1 and 2. No assessment.
3. Six.
4. No.

Obstructions to the Passage of Fish—
1. None. One partially erected at foot of Loch Naver, but not completed; free access for fish still.
2. None fished.
3. Yes.
4. No.
5. Yes.
6. No.
7. Nothing.

Pollutions—
None.

The Salmon Disease—
No disease.

The Spawning Season—
1. 25th October.
2. 31st October to 18th November.
3. 1st December, a few noticed spawning on 25th December.
4. Medium level.
5. Less.
6. Halladale to Grudie.

Kelts—
1. 15th March.
2. April.
3. May.
4. Medium level.

Smolts—
1. From 10th to 30th May.
2. About the average.

Artificial Propagation of Salmon—
No; but one near, at Sandside, Caithness, capable of hatching 200,000 ova.

Proportion of Male to Female Salmon—
About one-fifth more males than females observed during spawning season.

SUTHERLAND, WEST COAST DISTRICT.

Take of Fish—

1. (*a*), (*b*), (*c*) and (*d*) Below the average.
2. (*b*) 1,141 salmon, 3,024 grilse, 203 trout; (*c*) about 150.
3. (*a*) Early in June; (*b*) July and August; (*c*) July and August, by rods.
4. (*b*) March—Salmon, 2·27 per cent.; April—Salmon, 5·78 per cent.; May—Salmon, 31·72 per cent.; grilse, 2·7 per cent.; June—Salmon, 38·12 per cent., grilse, 36·9 per cent.; July—Salmon, 20·6 per cent., grilse, 55·2 per cent.; August—Salmon, 1·4 per cent., grilse, 5·10 per cent.
5. (*b*) Not known. (*c*) Uncertain; 33 lbs. on the River Inver.

Protection—

1. No assessment.
2. No assessment levied for protection.
3. Seven keepers, who watch the river.
4. No.

Pollutions—

None.

The Salmon Disease—

1. No signs of disease observed.

The Spawning Season—

1. On November 10.
2. 16th November to 20th December.
3. About the 1st of January.
4. Low to begin with, then medium level.
5. Apparently less.
6. Kirkaig, Inver, Laxford, Inchard, and Dionard.

Kelts—

1. About 24th March.
2. April.
3. Latter end of May.
4. Varying from medium to half-flood.

Smolts—

1. About the end of April.
2. No, not very good.

Artificial Propagation of Salmon—

There are two hatcheries in the district, one at Inchnadamph, Loch Assynt, and the other at Geisgill, near Scourie. About 80,000 fish could be hatched out in each annually.

Proportion of Male to Female Salmon—

No, not with any degree of accuracy.

General Question—

No.

THE DISTRICT OF THE RIVER BALGAY.

No answers have been received.

THE DISTRICT OF THE RIVER TORRIDON.

No answers have been received.

THE DISTRICT OF THE RIVERS PENNYGOWN AND AROS.

This Board has only recently been constituted, and is not yet in proper working order. The Board has therefore had no means of ascertaining the information necessary for answering this circular.

THE DISTRICT OF THE RIVER LUSSA AND RIVER FROM LOCH MUISK TO LOCH BUY.

This Board has only recently been constituted, and is not yet in proper working order. The Board has therefore had no means of ascertaining the information necessary for answering this circular.

THE DISTRICT OF THE RIVERS BAA AND GOLADOIR.

This Board has only recently been constituted, and is not yet in proper working order. The Board has therefore had no means of ascertaining the information necessary for answering this circular.

THE DISTRICT OF THE RIVER LOCHY.

Take of Fish—
1. Below.
2. No.
3. (*a*) April.
4. No nets or fixed engines.
5. (*c*) 38 lbs.

Protection—
1. £2,115 6s. 1d.
2. 1d. per £; and, in addition, Lord Abinger pays all the expenses of watching on the Lochry and Spean rivers.

Obstructions to the Passage of Fish—
1. None.
3. No dams or cruives.
4. No.
5. Always a free passage.
6 and 7. No.

Pollutions—
1 and 2. No

The Salmon Disease—
1. No disease.
3. None.
4. No.

The Spawning Season—
1. 25th October on tributaries.
2. Between second week in November and end of second week in December.
3. End of December.
4. Low upon the whole.
5. Less.
6. Roy, Spean, Cour, Lochy, Gloy, Nevis, and Arkaig.

Kelts—
1. Not known.
2. March and April.
3. Last week in April.
4. High.

Smolts—
1. May.
2. No.

Artificial Propagation of Salmon—
A small hatchery, supported by Lord Abinger; hatched out in it last year 115,000.

Proportion of Male to Female Salmon—
About one-fourth more male than female; enumerated from actual catch.

THE DISTRICT OF THE RIVER AWE.

No answers have been received.

THE DISTRICT OF THE RIVER AYR.

Take of Fish—
1. Rather above average.
2. No.
3. The main take of salmon towards end of season.
4. The fishings in the sea were let, and the tenant would not give information.
5. Not known.

Protection—
1. £100.
2. 8s. per £, in all £40.
3. One water bailiff.
4. One prosecution for fishing with the otter, and conviction obtained. Penalty £2, with 30s. towards expenses.

Obstructions to the Passage of Fish—
1. None.
2. No cruives in district.
3. No; action being raised against the town of Ayr to compel the formation of salmon ladder in dam dyke at Overmill.

4, 5, and 6. No.

Pollutions—
1 and 2. No.

The Salmon Disease—
No disease.

The Spawning Season—
Cannot give information.

Kelts—
Cannot give information.

Smolts—
Good smolt year.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

THE DISTRICT OF THE RIVER GIRVAN.

Take of Fish—
1. (*a*) None ; (*b*) cannot say ; (*c*) and (*d*) below the average.
2. (*a*) None ; (*b*) about 240 salmon, 670 grilse, 1,740 trout ; (*c*) cannot say.
3. (*a*) 1st April ; (*b*) August ; (*c*) about June 15th.
5. (*a*) None ; (*b*) 33 lbs. ; (*c*) cannot say.

Protection—
1. £524.
2. No.
3. None.
4. No.

Obstructions to the Passage of Fish—
1. No alteration.
2 and 4. No.
5. When in flood.
6 and 7. No.

Pollutions—
1 and 2. No.

The Salmon Disease—
1. No salmon disease in River Girvan.

The Spawning Season—
1. Latter end of December.

Smolts—
1. 1st May.
2. Average.

Artificial Propagation of Salmon—
None.

THE DISTRICT OF THE RIVER STINCHAR.

Take of Fish—
1. (*a*) Below the average.
2. (*b*)

Month.	Salmon.	Grilse.	Trout.
1897			
May, ...	8	...	...
June, . . .	52	33	34
July, . . .	73	81	76
August . . .	148	93	4
September 1st to 10th,	17	3	...
Totals, . .	298	210	114

(*c*) 41.
3. (*a*) 1st April ; (*b*) middle of August ; (*c*) end of June.
4. (*b*) Heaviest salmon, 35 lbs. ; heaviest trout, 7 lbs.
5. (*b*) 40 lbs ; (*c*) 30 lbs.

Protection—
2. No assessment.
3 and 4. None.

Obstructions to the Passage of Fish—
None.

Pollutions—
1. No.

The Salmon Disease—
1. No diseased fish in sea, little in river; February; about end of same month.
2. Small.
3. Four fish; two of each; kelts.
4. No.

The Spawning Season—
1. 1st December.
2. Middle of December and January.
3. 1st February.
4. Small.
5. Fully an average.
6. The River Stinchar.

Kelts—
1 and 2. March.
3. 10th May.

Smolts—
1. 1st April to middle of May.
2. Fair.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

THE DISTRICT OF THE RIVER CREE.

Take of Fish—
1. No special information, but the general opinion is that the take has been below the average.
2. No.
3, 4, and 5. No information.

Protection—
1. £671.
2. £50 6s. 6d., being the assessment at 1s. 6d. per £.
3. Two.
4. No.

Obstructions to the Passage of Fish—
1. No changes.
2. There are no cruives in this district.
3. Yes.
4. No.
5. Yes.
6. No.

Pollutions—
1. No.
2. None required.

The Salmon Disease—
1. No disease.

The Spawning Season—
No information.

Kelts—
No information.

Smolts—
No information.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

THE DISTRICT OF THE RIVER DEE (KIRKCUDBRIGHTSHIRE).

Take of Fish—
1. Much below; (*a*) 134 salmon, 575 grilse; (*b*) 742 salmon, 1325 grilse; (*c*) no fixed engines; (*d*) not known.
3. Main take April to July; grilse and sea trout begin to run in June.
4. Much depends on the state of the river.
5. (*a*) 30 lbs.; (*b*) no fixed engines; (*c*) 26 lbs.; heaviest trout 8 lbs.

Protection—
1. £1603.
2. £5 per cent.
3. Twelve.
4. No.

Obstructions to the Passage of Fish–
1. No change.
2. No cruives.
3. Yes.
4. No.
5. Free run at all times.
6. None.
7. No.

Pollutions—
1. No.
2. None.

The Salmon Disease—
1. No.
3 and 4. None.

The Spawning Season—
1. End of October.
2. 1st November to end of December.
3. 3rd January 1897.
4. Not ascertained.
5. No.
6. Dee, Tarff, and Ken.

Kelts—
1. 1st March.
2. End of March and beginning of April.
3. End of May.
4. Not known.

Smolts—
1. 20th April to end of May.
2. No.

Artificial Propagation of Salmon—
Private enterprise; Tongland, 200,000.

Proportion of Male to Female Salmon—
Cannot ascertain.

General Question—
No.

THE DISTRICT OF THE RIVER NITH.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below the average.
2. (*a*), (*b*) and (*c*) Cannot be given.
3. Clean fish are caught as soon as the fishings open on 24th February ; but afterwards, from about middle of March, no clean fish are got till the sea-trout begin to run in April.
4. (*a*) and (*b*) Cannot be got.
5. (*a*) 28 lbs. ; (*b*) 34 lbs. ; (*c*) one of 40 lbs. was caught at Dumfries.

Protection—
1. £780 5s. 6d.
2. 2s. 6d. per £.
3. One man employed and paid by the Board, and over twenty gamekeepers sworn in as special watchers.
4. Yes ; five men for using drag hooks in fish pass fined £5 10s. 6d each, or a month's imprisonment ; one man 38s., or 14 days, for snatching ; one man 32s. 6d., or 14 days, for having smolts in possession ; four men £2 each, or a month's imprisonment, for fishing in close time with drag hooks in fish pass.

Obstructions to the Passage of Fish—
1. A pass has been constructed on caul at Cairnmill, Keir and Penpont parishes, but it is questionable whether it is effective or in accordance with provisions of Schedule G of Salmon Act.
2. Been fished as usual.
3. One cruive in the district is, but the dams are not. Most of the latter have neither passes, hecks, or sluices in accordance with the Schedule.
4. No, except the pass on the Scaur at Cairnmill.
5. Yes, when fish are running after a flood ; but when the rivers are low, the passes do not facilitate the passage of fish.

6 and 7. No.

Pollutions—
1 and 2. No.

The Salmon Disease—
1. Very little ; it was only in March, and a few kelts were affected.
2. Low, when it was seen.
3. None taken.
4. No.

The Spawning Season—

1. In October.
2. From middle of December to middle of February.
3. About end of March.
4. Fish only spawn after a flood, and not when river is low.
5. Less.
6. There are spawning streams all along its course.

Kelts—

1. March.
2. May.
3. In beginning of year.
4. Kelts only go to the sea when the river is rising to a flood, or at least rising.

Smolts—

1. April and May.
2. No.

Artificial Propagation of Salmon—
No; Armistead's private hatchery.

Proportion of Male to Female Salmon—
Cannot be given.

General Question—
No.

THE DISTRICT OF THE RIVER ANNAN.

Take of Fish—

1 (*a*), (*b*), (*c*), and (*d*) Below the average.

2. The lessees of the different fishings say they do not keep a record of number caught, therefore the number cannot be given.

3. (*a*) 25th February, first open day; (*b*) during August; (*c*) week ending 19th June. Were much below average in number; grilse, during July, has been poorest for last 20 years, and some old fishermen say it was the worst on record.

4. With exception of on the Newbie Fishery, no record is kept of fish caught each month, therefore this cannot be given. I understand the manager of Newbie Fishery sends notes of those caught there to Mr. Archer.

5. (*a*) No net and coble fishing in district; (*b*) 39 lbs. (on Newbie Fishery in August); (*c*) 28¾ lbs. (in Mount Annan Waters).

Protection—

1. £3,181 10s.
2. £477 4s. 6d.
3. Four (three at Annan and one at Lochmaben), also twenty-eight gamekeepers sworn in as water bailiffs.
4. Fourteen persons were prosecuted, thirteen of whom were convicted (one for three offences and one for two offences), viz., one for contravention Sec. 17 of Act 1868, fined £6 13s., or 30 days; two for contravention Sec. 20 of Act 1868, fined each £1 12s. 6d., or 14 days; two for contravention Sec. 19 of Act 1868, admonished; two for contravention Sec. 33 of Annan Act, fined each £1 10s. 6d., or 14 days; one for contravention Bye-law, Sch. G, admonished; three for contravention Sec. 27 of Act 1862, fined each £2 10s., or 21 days; two for contravention Sec. 15 (Sub-Sec. 1) 1868 Act, fined each £2, or 21 days; three for contravention Sec. 21, 1868 Act, one of which was fined £12 13s., or two months, others £2, or 21 days. *Note.*—These sums include the expenses awarded.

Obstructions to the Passage of Fish—

1. Only alteration is on the caul at Brydekirk Mill, on the Annan, where the Fishery Board have built a new portion on the face of the dam, close to the east bank, from the top full half-way down, which gives a fall of *one in sixteen*, and which has been a great advantage in allowing salmon to ascend.
2. None in district.
3. Yes, with following exceptions, viz.:—On the Annan—No heck at intake or tail of race at Annan Mill, belonging to Joseph Forster, wadding manufacturer; no heck at tail of mill race at Brydekirk Mill, belonging to Francis Henry Wilson. On the Kirtle—There are three dams, viz., Rigg, Beltenmount, and Kirtlebridge, neither of which have a pass nor hecks on mill race. Rigg Mill is not now used.
4. No alteration.
5. Yes, with exception of Brydekirk fish pass, which is deficient at all times.
6. No.
7. No change.

Pollutions—

None, save Lockerbie and Moffat sewage, both of which places are receiving attention with the view of remedy.

The Salmon Disease—

1. Yes; first observed 24th January; at its height middle of March; and disappeared beginning of April.
2. Low.
3. Yes; in February one, and in March nine, eight of which were male and one female; all kelts (one male from Kinnel on 16th January, kelt); very few seen diseased during the year.
4. None.

The Spawning Season—

1. 9th November.
2. During January.
3. About middle of March.
4. Medium.
5. Less in early part of season; afterwards average.
6. Annan and its tributaries, Kirtle, Kinnel, Ae, Mein, Milk, Dryfe, Moffat Water, Evan.

Kelts—

1. 8th February.
2. During March and April.
3. First week in June.
4. Medium.

Smolts—

1. End of April, principally in May.
2. Below the average.

Artificial Propagation of Salmon—

None in district.

Proportion of Male to Female Salmon—

No; the only fishery where a record of this is kept is at Newbie. I understand the manager there sends a return of this to Mr. Archer.

General Question—

Nothing further than it would be well to keep in view the complicated state of the Acts referring to the Solway.

NOTE II.

CORRESPONDENCE BETWEEN THE NORTH ESK DISTRICT BOARD AND THE FISHERY BOARD FOR SCOTLAND REGARDING THE CRAIGO AND MORPHIE DAM DYKES, AND REPORT ON THE SAID DYKES BY MR. WALTER E. ARCHER, INSPECTOR OF SALMON FISHERIES FOR SCOTLAND.

1. Mr. Dickson, Clerk of the District Board, to the Secretary of the Fishery Board, dated 16th February 1897.

Sir,—At the spring meeting of the Board on the 12th inst., it was resolved to apply to your Board for the services of an expert to report upon the state of the Morphie and Craigo dam dykes, and the bed of the river in their neighbourhood. I trust it will be quite convenient for your Board to accede to their request.—Yours, etc.,

Arthur Dickson.

2. The Secretary of the Fishery Board to Mr. Dickson, dated 19th February 1897.

Sir,—I have to acknowledge receipt of your letter of 16th inst. on the subject of the Morphie and Craigo dam dykes, and I have to state for the information of your Board that your communication will be laid before the next meeting of the Fishery Board for Scotland.—I am, etc.,

W. C. Robertson.

3. The Secretary of the Fishery Board to Mr. Dickson dated 18th March 1897.

Sir,—With further reference to your letter of 16th ult., asking a report by an expert on the Morphie and Craigo dam dykes, I have to inform you that the matter was considered by the Fishery Board for Scotland at a meeting held on 12th inst., when I was directed to state that the Board presumed that your Board would not have made this request unless they were of opinion that the dam dykes in question formed a serious obstruction to the passage of fish, and that their efforts to deal with the matter had failed, and that they were therefore prepared to comply with the request.

Before issuing any instructions on the subject, however, they desired to know the circumstances under which the application was made, the steps which your Board had already taken in the matter, and the action they proposed taking in the event of an expert reporting that the present state of the dam dykes was unsatisfactory.—I am, etc.,

David T. Jones,
For Secretary.

4. Mr. Dickson to the Secretary of the Fishery Board, dated 9th April 1897.

SIR,—Your letter dated 18th ult. was submitted to the District Board at their meeting to-day, and I was instructed to reply in the following terms, viz. :—

1. That Colonel McInroy of The Burn was elected a member of the District Board in September last, and that the application to your Board for a report by an expert was made on the motion of Colonel McInroy on behalf of himself and of several other proprietors of the upper fishings.
2. That this Board have not already taken any steps in the matter, and now wish a report by an independent person.
3. That their action will be regulated by the terms of his report.

The river is generally low in the beginning of June, and if, convenient for the Expert to visit it about that time, I shall be glad to hear from him previously.—I am, etc.,

ARTHUR DICKSON.

5. The Secretary of the Fishery Board to Mr. Dickson, dated 29th December 1897.

SIR,—At a meeting held on 23rd inst. the Fishery Board for Scotland had under consideration a report, dated 20th inst., by Mr. Walter E. Archer, Inspector of Salmon Fisheries for Scotland, of a visit to the Morphie and Craigo dam dykes, which formed the subject of your letters of 16th February and 9th April last, and in accordance with the directions of the Board, who approved of the conclusions arrived at by Mr. Archer, I enclose a copy of the report for the information of the North Esk District Board.—I am, etc.,

W. C. ROBERTSON.

6. REPORT BY MR. WALTER E. ARCHER, INSPECTOR OF SALMON FISHERIES FOR SCOTLAND.

I have the honour to report, for the information of the Fishery Board for Scotland, that in accordance with my instructions I visited the river North Esk on the 16th July, and on the 16th and 18th October last, for the purpose of reporting on the state of the Craigo and Morphie dam dykes and the bed of the river in their immediate neighbourhood.

Members of District Board and others met with in the course of the inspection.

I was accompanied on my inspection by Mr. Arthur Dickson, clerk to the District Board of the River North Esk, and was met at the riverside by several members of the District Board, proprietors and tacksmen of salmon fisheries, water bailiffs and others, and had the advantage of hearing their views.

Provisions of Bye-law, Schedule G.

In the bye-law (Schedule G, 31 and 32 Vict., c. 123) which regulates the construction and use of mill dams, certain definite rules are laid down with regard to the position, the *minimum* dimensions, and the *maximum* gradient of fish-ladders, and in addition it contains the following general provision, viz. :—"There shall be a salmon pass or ladder "on the down stream face of every dam, or weir, or cauld, capable of "affording a free passage for ascending fish at all times when there is "water enough in the river to supply the ladder." From the decision given in the case of Myers *v.* Grant, a case in which the proprietor of Craigo dam dyke was ordered to make sufficient provision for the free passage of salmon in terms of the bye-law, it would seem that in order to fulfil the requirements of the bye-law a fish-ladder must be efficient as affording an uninterrupted passage for salmon. With regard to this case I may mention that I am given to understand that the proprietors of Craigo hold that they are exonerated from all further obligation with reference to the construction of the pass, seeing that the Court of Session, to whom the case was appealed, found that the pass should be altered in terms of the several reports made by Mr. Stevenson, civil engineer, Edinburgh, and that the alterations proposed by him were given effect to. This, however, appears to be a question of law which it is not for me to decide.

For the sake of convenience I propose to deal with Craigo and Morphie dam dykes separately.

CRAIGO DAM DYKE.

In reporting on the state of Craigo Dam Dyke, I propose, after describing the form and dimensions of the dyke and fish-pass, to consider, (1) in what respects, if any, the latter is not constructed in accordance with the definite rules laid down in the bye-law; and (2) whether, in other respects, it affords a free passage for salmon; (3) to summarise the conclusions arrived at on these two points: (4) to point out remedies; and (5) to make recommendations.

Dimensions of Craigo Dam Dyke and Fish-Pass.

It will be seen from a plan and section of Craigo dam dyke made on the 8th July last, by Mr. Sim, civil engineer, Montrose, that the dyke is 423 feet 9 inches long, and that it raises the water in the dam to a height of about seven and a half feet above the water in the pool below. This height, however, varies, of course, with the rise and fall of the river.

The length of the pass is 70½ feet, and it rises in that distance 6·69 feet in height, or at an average gradient of one perpendicular to ten and a half horizontal. But the inclination is not uniform throughout, the steepest part being in the upper fourteen feet, where it rises one foot in every six. The foot of the pass projects about 30 feet beyond the toe of the dam.

The width of the pass is four feet two inches for the first three feet of its length, reckoning from the upper end, six feet six inches for the following forty-one feet eight inches, and eight feet in the last twenty-six feet of its length.

The upper sill of the pass is one foot nine inches below the crest of the dam, but there is no means of regulating the flow of water to the pass.

The stops, of which there are eleven, are about two feet long, and eight inches high. They are placed at a distance of five feet apart, commencing fourteen feet from the intake and continuing to the entrance.

In what respects the definite rules laid down in Bye-law contravened.

It will be seen, therefore, that the fish-pass is not constructed in accordance with two, at least, of the definite rules laid down in the bye-law, viz.:—1st, the foot of the pass projects beyond the toe of the dam, and no apron of stone extends throughout its whole length on either side of the pass; and 2nd, the width of the pass is less than six feet, although the length of the dam is more than 200 feet.

With regard to the position of the foot of the pass, its projection beyond the toe of the dyke is a very great defect. For, as pointed out by Mr. Atkins in his report "On Fish-ways," in ascending a river salmon follow the main stream until met by an obstruction. At the foot of this they swim to and fro trying to ascend. If unsuccessful, they will after a time drop back to the nearest pool to rest. But on their next attempt they will again ascend to the foot of the obstruction, to be again baffled, and thus repeatedly pass the mouth of a ladder which enters the river below the obstruction without noticing it. In constructing a fish ladder, therefore, one of the chief objects to be aimed at is to place the entrance at the furthest point to which the fish can reach in their ascent of the main stream. An attempt has been made to remedy this defect by placing stones on the north side of the pass so as to form a lead for the fish. This expedient may modify the injurious results of this defect when the river is low, but is not of much use when the river is at a medium or high level and the fish most inclined to travel. On the 16th and 18th October, when eight to fourteen inches of water were flowing over the crest of the dam, salmon were collected in large numbers in the pools higher up than the entrance to the pass, from which they were attempting to ascend the face of the dam, but it was only on the north side that they were ever successful.

With regard to the width of the intake, it may be stated generally that the larger the volume of water in the pass, provided it does not cause too great turbulence in the chambers, or too great resistance to the fish, the more will fish be attracted to it. No benefit, however, would be derived from widening the intake if its depth were reduced. On the contrary, if the volume of water is not increased, it is better that the intake should be narrow and deep than broad and shallow, as it admits of the ladder being supplied with water at a lower state of the river.

Whether in other respects the Fish-Pass affords a free pass for Salmon and if not, wherein it is defective.

In considering whether in other respects the fish-pass affords a free passage for salmon, and, if not, wherein it is defective, I propose to point out, 1st, the principles generally aimed at in the construction of fish-passes, and the causes of failure in application; 2nd, the defects of construction in Craigo fish-pass; and 3rd, the opinions expressed as to its efficiency by those present at the inspection.

1st. Now, it is well known that the further a falling body descends unobstructed the greater the force it attains, and in order, therefore, that water descending from a height, at a steep gradient, may not offer too great resistance to fish, it is necessary to check its velocity at frequent intervals. Numerous systems have been devised for breaking the force of the current in a fish-pass without causing too great disturbance of water. There are Smith's, Forsyth's, Atkins's, Brackett's, Cail's, Forster's, Swazey's, Pike's, Roger's, Hockin's, and many other systems. These systems, which differ in many respects, have, as a rule, one feature in common—viz., that whenever the gradient is as steep as one perpendicular to ten horizontal, the openings in the stops and the width of the pass bear such a proportion to one another that, when the pass is in working order, a cushion of quiet water is secured in each chamber against which the descending current expends its force before passing on to the next chamber. But although numbers of these passes have been erected, but few of them—probably not more than half a dozen—have proved effective. Their non-success seems due to the following causes, viz.:—(1), That the volume of water in rivers is constantly fluctuating, thus causing at most times a greater or less quantity of water to flow down the passes than they are constructed by their inventors to carry, and thereby throwing them out of working order, as such passes are usually put up promiscuously without proper attention being paid to the regulation of their water supply; and (2), that they do not carry a sufficient volume of water to attract salmon readily to ascend them.

2nd. With the view of studying the efficiency of the pass at Craigo, which is constructed somewhat after the Forsyth system, and of seeing whether there are any special circumstances connected with its local position or construction which make it more likely to be effective than most passes of this type, I visited it, as already stated, on three occasions. On my first visit the river was at dead low summer level, and the water having been shut off from the fish-ladder by means of a wooden sluice, I was able to examine its construction. On my two subsequent visits the river was in moderate flood, but not so high as to prevent my wading along the crest of the dam to the head of the pass.

I found nothing in the position or the construction of the pass to lead me to think that it was more likely to be effective than other passes constructed on the same system. On the contrary, it seemed to me to be a bad specimen of its type, and to afford a passage for salmon at even fewer different variations in the water level than is usual with such passes. In the first place, the stops are so low that they do not sufficiently arrest the velocity of the current; in the second, the openings in the stops, particularly in the lower end of the pass, are wider than the intake, consequently when the river is low sufficient water is not retained in each chamber; in the third, the width of the pass is in no place more than one and a half times greater than the width of the openings in the stops, consequently even in a moderate flood no cushion of quiet water is secured in each chamber against which the descending current can expend its force before passing on to the next chamber; on the contrary, great turmoil is caused by the current striking against the stops; and in the fourth, the widening of the pass at three feet from the intake, and the steep gradient at which it is placed at its upper end, causes the water to descend with so great velocity that, even in a moderate flood, salmon must have great difficulty in ascending the upper fourteen feet—and the higher the river the more would the difficulty increase.

3rd. Considerable difference of opinion prevailed among those whom I met at the river-side with regard to the efficiency of the pass. By some it was contended that it is of little or no use; by others, that salmon ascend it freely at certain heights of the river. The former stated, in support of their opinion, that, under present circumstances, not more than half a dozen fish are taken annually in their waters during the net fishing season; whereas in 1881, when a breach had been made both at Craigo and Morphie dykes, some 300 fish were taken. The latter based their opinion on observation, stating that they had seen numbers of salmon ascend the pass when the river was at a medium height, but that when it is in flood they ascend the dyke itself on the north side.

The conclusion arrived at.

Taking into consideration the defects which obtain in Craigo pass—viz., 1st, as to the position of its mouth; 2nd, as to the width of the intake, and, 3rd, as to the plan on which it is constructed—it seems to me that it can never afford an easy or attractive passage for salmon, and that it must be thrown out of working order altogether by very slight variations in the water level. I am disposed to think that the probable explanation of the apparently conflicting opinions above referred to is that, although some salmon may ascend it under certain conditions of weather and water, these conditions occur so seldom that the great majority of fish are taken at the foot of the dyke while waiting for favourable conditions to ascend it, and that but few, therefore, reach the upper waters until after the close of the net fishing season. I cannot, therefore, conceive that it can be considered to afford a free passage for salmon at all times in terms of the bye-law.

Remedies proposed.

With regard to what should be done to provide such a passage I have no confidence in any alteration or the present pass. Although such passes if properly constructed sometimes work in places where there are no conflicting interests, and where, therefore, the fish are allowed to remain undisturbed in the pool below until the conditions are favourable for them to ascend, they are quite ineffective when nets are used right up to the foot of the obstruction. It must be borne in mind that it requires but a slight obstruction to check the passage of salmon under certain conditions of weather and water; *e.g.* in the winter or early spring months, unless the weather is very open, salmon *will* not ascend obstructions which hardly check their progress later in the year, while heavily-laden female salmon ascending rivers on the eve of spawning *cannot* surmount obstructions which present but little difficulty to fish entering the rivers in the summer months; and at all seasons of the year the water level plays an important part in the extent to which a fall obstructs the passage of salmon. In any case, therefore, dam dykes always check the passage of salmon to some extent, and if netting is allowed close up to their foot they not only serve their legitimate purpose of supplying water to mills but facilitate the capture of fish. To check as far as possible their serving this double purpose, which I understand to be the intention of the general provision contained in the bye-law, fish-passes should be formed of a series of pools extending if possible the whole width of the river, so that salmon in following the natural course of the stream have no choice but to ascend them, or at any rate the lower pools should be constructed in such a manner that the greater body of water passing over the crest of the dyke flows through them, thus causing the entrance to the pass to form the main channel of the river. Further, the pools should be made of such length and depth that, in times of flood, the water does not jump from one stop to another or cause undue disturbance, and the rise between each pool should not exceed 12 or 13 inches. In England, where fish-passes must be constructed of such form and dimensions as are approved by the Board of Trade, it would seem that it is now generally recognised that in order to secure. as far as possible, a free passage for salmon they must be constructed on these principles. Mr. Berrington, in the 26th Annual Report on Salmon Fisheries (England and Wales), p. 23, remarks that "it is lamentable going about the country to see the "numbers of useless fish-passes with which the weirs are studded. "Of these only a small fraction have received formal approval, and of "those which have been approved but few are really efficient, as will be "seen by the list on the following pages (24, 25)."

"In this list it would be difficult to find half a dozen passes of "magnitude which are really effective. . . . . . The fish passes "which have been made throughout the country represent the expenditure of a large sum of money, the greater part of which has yielded "nothing but experience. This properly utilised is, however, a distinct "gain, and as the fish-passes of the present day will, it is hoped, show "an improvement on those of the past, so we may trust that our "successors will profit by our mistakes and produce better work than "our own."

If we turn to the Thirty-fifth Annual Report on Salmon Fisheries (England and Wales), we shall find, facing page 14, plans and sections of the fish-passes which the dearly-bought experience above referred to has resulted in producing. It will be seen that the ladder form, which found favour in the early days of fish-passes, when the matter was but little understood, is discarded, and the form of fish-pass which I have ventured to recommend, and of the effectiveness of which I have had personal experience, is adopted in its place. Reference to these plans will show that a pool-pass as now understood is very different to that designed by Mr. Stevenson in 1871, which was in use at Craigo up to 1881.

It may be objected that a pool fish pass is not the form of pass contemplated in the bye-law, and that the rules there laid down indicate that all that is necessary to meet the requirements of the bye-law is a fish ladder after the Forsyth system. This view would seem to be borne out to a certain extent by the note appended to sec. 6 of Schedule G. On the other hand, it could be argued that the dimensions laid down in sec. 6 are the *minimum* dimensions, below which no pass may be constructed, and that the general provision as to every pass or ladder affording a free passage to fish at all times when there is water enough in the river to supply the ladder is to meet the very wide difference which must necessarily exist in the form and dimensions of fish passes constructed at dams of different heights and shapes; and, therefore, in order to meet the requirements of the byelaw, it is essential that this general provision should be given effect to. This view would seem to find support in the decision given in the case of Myers *v.* Grant.

If this latter view is correct it would seem probable that the court in directing alterations to be made in an inefficient pass would take into consideration the requirements which modern experience has shown are necessary in order to produce an efficient pass.

Recommendations.

In conclusion, I would venture to point out that the channel at the foot of the dam on the north side of the present pass offers facilities for the construction of a good pool pass on the lines which I have recommended. I desire, however, to impress upon those interested in the salmon fishings that it must always be borne in mind that at best a fish pass is but a makeshift, and that, however good, it can never compensate a fishery for the existence of a dam dyke. The course which would commend itself to me, if a reasonable bargain could be made with the proprietor, is the purchase and removal of the dyke. I venture to recommend this course as that which would tend most to the development of the capacity of the river for the production of fish, and as that which would be most remunerative to the proprietors of the rod fishings in the upper waters.

MORPHIE DAM DYKE.

The construction of the Dam Dyke and Fish Pass.

In dealing with the state of the Morphie or Kinnaber dam dyke, I propose to consider (1) the construction of the dam dyke and fish pass; (2) the state of the bed of the river in the immediate neighbourhood of the dyke; (3) the complaint as to the volume of water abstracted by the Kinnaber lade; and lastly, to summarise the conclusions arrived at on these several points.

The fish pass at Morphie, although at first sight presenting considerable similarity, will be found on more careful study to be in striking contrast to that at Craigo. The dissimilarity in these passes lies principally in their position and in the heights which they have to overcome. The Morphie fish pass is 44 feet long, 5 feet wide, and rises 4 feet. As in the case of the fish pass at Craigo the gradient is steepest at the upper end. No stops are shown in the plan made by Mr. Sim, nor was I able to see whether there were any, as water was flowing through the pass when I inspected it ; but from the photograph taken in 1882, which is appended to Mr. Sim's plan, it would seem that there are, and that they are very similar in size to those in the fish pass at Craigo. The upper sill of the pass is 1 foot 9 inches below the crest of the dyke.

The dyke is V shaped, the angle of the V being placed up stream, and either arm extending down stream for about three hundred and seventy to three hundred and eighty feet, until they touch the banks of the river on either side. The fish pass is placed on the north arm, about twenty-five feet below where it joins the south arm, and the stream from the mouth of the pass is poured right across the channel formed by the dyke at a point where it is not more than fifteen feet across, so that salmon ascending the river are led by the converging arms of the dyke right up to the entrance of the pass.

It has been pointed out that the entrance to a fish pass should be so constructed that the greater body of water passing over the crest of the dyke flows from the foot of the pass, as the power of a fish pass to attract salmon is in proportion to the volume of water discharged from its lower end. The Morphie fish pass, from its exceptional position, is an admirable illustration of the application of this principle. The entrance to the pass practically begins at the point where the arms of the dyke touch the banks of the river, and embraces therefore the whole natural channel. From this point the pass may be said to gradually contract in size, and the volume of water pouring down it at the same time to diminish. But although it diminishes, it forms always the main stream, and offers, therefore, a natural and attractive passage for salmon.

The actual construction of the fish pass proper seems to me to offer no point worthy of imitation. On the contrary, the greater ease with which salmon ascend Morphie than Craigo fish pass is, in my opinion, due (1) to its position ; (2) to the lower height of the dyke ; and (3) to the shape of the dyke. It is owing to the pass being placed across the general direction of the stream that the water flowing over the dyke strikes the water flowing down the pass at an angle, thus checking its velocity and creating comparatively quiet water on the sheltered side of the pass, in which the fish can ascend without difficulty. It is perhaps superfluous to point out that, other things being equal, the lower the dyke the less obstruction it presents to the passage of fish ; and it is owing to its shape that, while the water level fluctuates comparatively slightly in the pool above, it rises very quickly at the foot of the dyke, so that even in a moderate flood the difference of four feet shown in Mr. Sim's plan between the level of the water above and below the dyke is reduced by about one half

It would seem to me therefore that Morphie fish pass not only possesses an attractive entrance in a proper position, but affords as easy a passage for salmon as is possible in a pass of that description. Their passage would, however, be still further facilitated if subsidiary dams, each raising the water one foot in height, were placed across the channel formed by the two arms of the dyke, and by this means the water at the foot of the dyke were raised to within one or two feet of the upper sill of the fish pass.

The state of the bed of the river in the immediate neighbourhood of the dyke.

There was a great difference of opinion amongst those whom I met as to the state of the bed of the river in the immediate neighbourhood of the dyke. By some it was contended that the lower end of the fish pass had fallen into disrepair, causing the water, instead of keeping in one channel, to spread out and form a shallow bank a short distance below the dyke, which prevented fish in low water from reaching the foot of the pass. By others that no alteration had taken place either in the lower end of the pass or in the gravel bank referred to.

I am unable to attach much importance to this complaint. In the first place, even if a few stones are out of place at the foot of the pass, they do not cause any real obstruction to the passage of fish, as the foot is entirely submerged when the river is at such a height that fish are inclined to travel. I am, however, by no means satisfied that there are any stones out of place, although this can be ascertained and, if necessary, rectified when the river is low. In the second place, the gravel bank referred to does not seem to me to present any real hindrance to fish; on the contrary, I believe it rather assists than hinders their ascent, by helping to dam back the water on the foot of the dyke.

The complaint as to the volume of water abstracted by the mill lade.

The complaint with regard to the abstraction of water by the Kinnaber lade seems to me a more serious matter. It was complained, in the first place, that since the introduction of turbines about six or seven years ago, a greater quantity of water is abstracted from the river than formerly; and in the second place, that it is most unjust that the Kinnaber lade should be exempted by the 12th section of the Act of 1868 from the provisions of the bye-law (Schedule G) as to the shutting of sluices at the intake.

With regard to the first point, there can be no doubt that the abstraction of a greater volume of water by the Kinnaber lade increases the difficulty which the dam dyke presents to the free passage of fish, but it hardly seems that, as the law at present stands, using a method of water power which abstracts more water constitutes a contravention of the statute. The 7th section of the bye-law (Schedule G) refers merely to the construction of the dam, and in this case the dam has not been altered. It would seem probable, however, that at the time of the passing of the bye-law the introduction of improved machinery into mill lades, by which a greater quantity of water could be abstracted from the rivers, was not contemplated, and that it was intended, by providing that "no dam shall be so altered as to create a greater "obstruction to the free passage of fish than at present exists," to safeguard the salmon fishery interests, and to prevent anything being done to increase the obstruction caused by mill dams to the passage of fish. If so, modern inventions have rendered the bye-law insufficient, and its amendment would seem to be required. The only power, however, given under the Salmon Fishery Acts for the amendment or alteration of the Commissioners' bye-laws would seem to be that given in the 9th section of the Act of 1868. By this section it is enacted that a District Board may petition the Secretary of State, whose duties are now performed by the Secretary for Scotland, to do certain things, viz. :—*inter alia* "to alter the regulations with respect to the construc-"tion and use of cruives and cruive dykes or weirs within their "district." It seems doubtful, however, whether the word "weirs" as used in this section refers to mill dams; but even if it does, and if application may be made to the Secretary for Scotland to issue regulations applicable to dams used in connection with turbines, the case of Morphie or Kinnaber is so special, in view of the provision of the 12th section of the Act of 1868, that it seems doubtful if the Secretary for Scotland could issue regulations affecting it.

It would appear from the case of the Tay District Board *v.* Robertson, 1887, 15 R. 40, that District Boards, being statutory Boards, have only power to prosecute for offences created by the statutes by which they have been established. If, therefore, as it seems to me, the abstraction of a greater volume of water is not an offence under the Salmon Fishery Acts of 1862, 1863, 1864, or 1868, it is not competent for the District Board to take action in the matter, but it must be left to the proprietors to vindicate any claims which they may have at common law themselves. The effect at common law is perhaps more doubtful, as it could be argued that the new method of using the water power is so different from the original method as to injure the salmon fishings of upper proprietors as anciently enjoyed. There is, however, so far as I am aware, no authority to justify such an argument. The question may also to a certain extent depend upon the charter under which the mill owner holds his right.

With regard to the second point, it is difficult to understand why the Kinnaber lade should be exempted from the bye-laws as to the shutting of sluices which are applicable to every other mill lade in Scotland.

From the reference to the lowering of the intake sluice during the weekly close time, which is made at the end of sec. 12, it would almost appear as if it were thought that the bye-law (Schedule G) provided that all the sluices should be entirely closed from 6 o'clock on Saturday afternoon to 6 o'clock on Monday morning, and that it was desired to modify this provision as regards Kinnaber lade in view of the great inconvenience that it would cause to the Royal Burgh of Montrose, seeing that the burgh depends for its water supply on the working of Kinnaber mill. From the opinions which were expressed to me it was evident that the view prevailed among some of those whose salman fishing interests were affected that if it had not been for the exemption contained in sec. 12, the sluices would be entirely shut on Sunday, and the water made to flow over the dam. But this was a mistaken view. The weekly close time applies to fishing only, and there is nothing in the bye-law which regulates dams, &c., to prevent the water being used for milling purposes at any hour of the day or night, on Sundays or on week days. Sec. 2 of the bye-law (Schedule G) does not in effect seem to go further than to provide that all water not required for milling purposes shall be made to flow over the dam into the river as far as practicable. Even to this rule there is an exception, as it is not imperative when the intake sluice is more than 300 yards from the water wheel to shut it, or to keep the bywash sluice shut during the ordinary meal hours or during any stoppage of the wheel not exceeding an hour at a time. It would seem therefore that this bye-law is very moderate, that it does not interfere with the privileges of mill owners, or do more than define what was practically the law before. It is, therefore, all the more difficult to understand why the mill at Kinnaber should be exempted from its provisions, or why closing the sluices at Kinnaber when the mill is not working should occasion greater inconvenience than closing them at any other mill in Scotland.

My attention was also directed to a very serious clerical error in sec. 12. The words, "not *less* than eighteen inches" are used in place of "not *more* than eighteen inches," thus making the slight concession to salmon fishing interests, which it was evidently intended to insert in the concluding lines of the section, quite useless.

For the complaints made with regard to section 12 there would seem to be no redress without fresh legislation, and I would venture, therefore, to submit this matter for the consideration of the Fishery Board.

In closing my report on the Morphie or Kinnaber dam dyke, I beg to summarise the conclusions at which I have arrived, as follows:—

Summary of conclusions.

1. That, owing to the form and dimensions of the dyke, the fish pass, although capable of improvement, probably affords as easy a passage for fish as is possible in a pass of that description.

2. That the bed of the river in the immediate neighbourhood of the dyke does not present any real obstruction to the passage of fish.

3. That the unavoidable difficulty which salmon experience in ascending every fish pass is in this case increased by the want of a sufficient volume of water to attract them, the deficiency of water being caused, (*a*), by the substitution of turbines in place of water wheels; (*b*), by the exemption, under sec. 12 of the Act of 1868 (31 & 32 Vict. cap. 123) of the lade from the bye-law as to the closing of sluices. As the law at present stands, however, it does not seem to me that the District Board can take any action beyond purchasing the dyke for removal in terms of the 13th section of the Act of 1868. I have the honour to be,

Your obedient Servant,

(Signed) WALTER E. ARCHER.

The Fishery Board for Scotland,
Edinburgh, 20th December, 1897.

7. Bye-law G, Regarding Mill Dams or Lades, Sluices, and Salmon Passes, &c.

Bye-law G., 25 & 26 Vict. c. 97—26 & 27 Vict. c. 50—27 & 28 Vict. c. 118. "Acts to regulate and amend the Law respecting the Salmon Fisheries of Scotland."

We, the Commissioners appointed under the said Acts, and empowered thereby 'to make general regulations with respect to the construction and alteration of 'mill dams or lades, or water wheels, so as to afford a reasonable means for the 'passage of salmon,' do hereby make the following general regulations with respect to the construction and use of mill dams or lades, or water wheels:—

1. Every new dam, and every portion of any dam that may require to be renewed or repaired after this time, shall be made and maintained watertight, or as nearly so as possible, so that no water that can reasonably be prevented shall run through the dam; but all water not taken into the lade for the use of the mills or other lawful purpose shall be made to flow over the dam as fully as may be practicable.

2. There shall be a sluice or sluices at the intake of every mill lade. No water shall, with the exception hereinafter stated, be allowed to enter any mill lade beyond the quantity required for the use of the water wheel or wheels of any one fall on that lade, or for other lawful purpose in the lade; that is to say, no water shall be allowed to escape from any lade into the river by means of any bye-wash or overflow, but all water not required for the uses aforesaid shall be made to flow over the dam into the river as far as may be practicable.

At the option of the millers or manufacturers, this provision may be carried out either by shutting the sluice or sluices at the intake of the lade, or by raising the banks of the lade to a height that will prevent an overflow of water from the lade when the sluice at the wheel and the bywash sluice hereinafter mentioned are both kept shut. Provided always, that the said bye-law shall not apply to millers or manufacturers when taking measures necessary for the protection of their premises during heavy floods, or when rivers are cumbered with ice, or while necessary repairs are being executed on any emergency, provided that nothing be omitted or done unnecessarily to defeat the objects of this bye-law. Furthermore, in all cases when the intake sluice is more than 300 yards from the water wheel, it shall not be imperative to shut the intake sluice, or to keep the bywash sluice shut, during ordinary meal hours, or during any stoppage of the wheel not exceeding an hour at a time.

3. At the intake of every lade there shall be placed and constantly kept a heck or grating for each opening, or one embracing the whole openings, the bars to be not more than three inches apart, if horizontal, and not more than two inches if vertical.

4. A similar heck or grating shall be placed and constantly kept across the lade or troughs immediately above the entrance to each mill wheel.

5. A similar heck or grating shall be placed and constantly kept across the lower end of each tail lade at its entrance into the main river.

NOTE.—To prevent any obstruction to the flow of the water by the hecks or gratings in the lades, it is recommended that the lade shall be increased in width where the hecks are placed, and that the heck, instead of being in a straight line across, should be curved or pointed up or down stream, and thereby increased in length, so that the aggregate of the openings between the bars shall exceed the sectional area (or waterway) of the lade, and thus compensate for the space occupied by the bars.

6. There shall be a bywash sluice placed as near as practicable above each water wheel in the embankment of the lade, of not less than three feet in width, with its sill as low as the bottom of the lade, and the said sluice shall be raised to a height sufficient to allow the smolts to descend for at least five but not exceeding eight hours each week from the 15th March to the 1st July, not more than six days intervening between each time of opening.

There shall be a salmon pass or ladder on the down stream face of every dam, weir, or cauld, capable of affording a free passage for the ascending fish at all times when there is water enough in the river to supply the ladder. The width shall not be less than four feet in the clear in rivers of less than 100 feet in breadth at the site of the dam, nor less than five feet in breadth in rivers of less than 200 feet and more than 100 feet in breadth as aforesaid, nor less than six feet in breadth in rivers of more than 200 feet in breadth as aforesaid; the upper sill shall be not less than six inches below the lowest part of the crest of the dam for the whole width of the ladder; the inclination shall in no case be steeper than five horizontal to one perpendicular, but wherever practicable, shall be seven or eight horizontal to one perpendicular, and in all cases shall be provided with breaks or stops placed at suitable intervals, so as to lessen the velocity of the current sufficiently to allow the fish to ascend without difficulty.

The foot of the ladder shall be placed where there is most running water, and with the best lead for the fish to approach it; and if the ladder should project beyond the toe of the dam, there shall be an apron of stone formed to the dam, extending as far down the river as the entrance to the pass or ladder, and extending throughout the whole length of the dam at either side of the ladder, and on a high enough level to prevent there being any pool in the river, or sufficient depth of water farther up than the entrance to the said pass or ladder, by which the fish might be induced to remain there obstructed in their ascent, and not be led to the ladder.

NOTE.—The Commissioners would recommend the following details to be adopted in the construction of salmon ladders, in addition to those given in the foregoing bye-law, but do not insist on them, provided some other perfectly efficient arrangement be substituted—viz., the side walls to be not less than twenty-two inches in height; the breaks to be not less than eighteen inches in height, with openings of ten inches in breadth at the alternate ends of each break, and five feet apart in cases where the gradient of the ladder is one in five and of a greater distance, but the same proportions being maintained where the gradient is easier than one in five.

7. No dam shall be so altered as to create a greater obstruction to the free passage of fish than at present exists.

WM. J. FFENNELL,
FRED. EDEN,
JAMES LESLIE,
} *Commissioners.*

Fisheries Department, Home Office,
29th day of April 1865.

Approved,
G. GREY.

Whitehall, 19th July 1865.

(This Bye-law to take effect from the 28th July1865.)

8. THE SALMON FISHERIES (SCOTLAND) ACT, 1868, SECT. 12.

XII. And whereas the royal burgh of *Montrose* is supplied with water from sources adjoining the river *North Esk*, which water is raised to the point of distribution by means of water power derived from a watercourse or mill-lade having its intake at *Morphie* dam dyke on the said river, and returning to the river at a point near the lower north water bridge on the said river, commonly called the mill-lade of *Kinnaber*, and great inconvenience would arise from the application to the said watercourse or mill-lade of certain of the bye-laws by this Act made valid and binding: Be it enacted, That nothing in the said bye-laws, or in this or in the recited Acts, or any of them, as to the placing of hecks or gratings, or the shutting of sluices at the intake of mill-lades or watercourses, shall apply to the said watercourse or mill-lade known as the mill-lade of *Kinnaber*, excepting in so far as regards the lowering of the intake sluice during the weekly close time, and then only so as to leave a free space during such close time of not less than eighteen inches between the bottom of the sluice and the sill or bed of such mill-lade or watercourse.

9. EXCERPT from LETTER from the late Earl of DALHOUSIE, K.T., (FOX MAULE) to DAVID LYALL, Esq. of Gallery, Member of the District Board, dated Invermark, Brechin, 24th August 1868:—

"I think I have influence enough with the Montrose people to persuade them "to forego any advantage which the slip you mention may give them, as it was "mainly through me they got the clause originally introduced into a former Bill."

NOTE III.

FIRST DIVISION.

(BEFORE THE LORD PRESIDENT AND LORDS ADAM, M'LAREN, AND KINNEAR.)

Special Case: The Duke of Fife and others for opinion and judgment.

A case involving questions of great importance to the salmon fisheries of Scotland was decided in the Court of Session, on the 23rd February 1897—viz., the Duke of Fife and others (34 Scottish Law Reporter, p. 440)—in which it was declared that the Duke, who held the right of cruive fishing on the river Deveron by grant from the Crown, was not entitled to maintain his cruives at the width fixed by the decrees of the Court, and at which width they had been maintained from time immemorial, but was bound to alter and construct them so as to bring them into conformity with the requirements of the Commissioners' Bye-law (Schedule F., 31 and 32 Vic. c. 123).

In this case the Duke of Fife, the first party, and Mr. George, clerk to the District Board of the River Deveron, the second party, being agreed upon the statement of facts, submitted the following questions of law for the opinion and judgment of the Court, viz.:—(1) "Is the first "party entitled, in the circumstances set forth, to maintain and continue "to use the said cruives at their present width; or (2) is the first party "bound, when called upon to do so by the Fishery Board (represented by "the second party), to widen the said cruives to a width of 4 feet each; "or (3) is the said Fishery Board entitled so to widen the said cruives?" The Court answered the first question in the negative, the second in the affirmative, and found that the third was superseded.

The circumstances set forth, on which both parties were agreed, were as follows, viz.:—

"1. The first party is proprietor, in virtue of Royal Grants or Charters "of very ancient dates, of the salmon fishings in the river Deveron, from "the sea for about four miles upwards. The said Royal Grants or "Charters, and the titles of the first party and his predecessors connecting therewith, comprehend the right of fishing both by cruives and by "net and coble. The first party is also proprietor of the lands on both "sides of the river for the same extent. The second party hereto is "Francis George, solicitor, Banff, Clerk to the Fishery Board of the "district of the river Deveron, for behoof of the said Board, under and "by virtue of Section 22 of the Salmon Fisheries (Scotland) Act 1862.

"2. The cruive dyke belonging to the first party is situated on the "said river Deveron, about two miles from the sea, near to the Rack "Mill, in the parish and county of Banff. In an action of declarator in

" the Court of Session, at the instance of Lord Banff and others, pro-
" prietors of upper fishings in said river, against James, second Earl of
" Fife, the predecessor of the first party, then in possession of said
" fishings and cruives, raised for the purpose of regulating the position,
" dimensions, and use of the cruives and cruive-dyke then belonging to
" the said Earl, and now belonging to the first party, and to prevent
" the withdrawal of water from the river at said cruive dyke by a lade
" for the said Rack Mill, the Court, by interlocutors dated 16th
" February and 8th December 1773, and 4th August 1774, found that
" the defender James, Earl of Fife, and his tacksmen, were entitled to
" maintain and uphold the cruive dyke now belonging to the first party
" in the form and shape in which it then was, but that the defenders
" were bound to place three cruives at least in the said dyke; that each
" of these cruives must be an ell in height, and an ell in breadth; that
" the rungs of the hecks must be placed perpendicularly at the distance
" of three inches from each other; that the sole trees of the cruives
" must be placed in the river so that the upper part of them shall be
" equal with the bed of the river; that the sole of the cruive boxes
" must be placed on a level with the bed of the river; and that all
" sharp pointed stones and other impediments which might prevent
" the salmon from entering the cruives must be removed; that
" the defenders were bound to observe the Saturday's Slap
" from six o'clock on Saturday afternoon till Monday at sunrising, and
" that during the said space the inscales of the cruives ought to be taken
" out and removed, but if, by reason of a flood in the river, the cruives
" could not be come at, the inscales in such case ought to be fixed back
" to the sides of the cruive boxes in such manner that the salmon might
" have a free and open passage; that in forbidden times the cruives
" ought to be totally removed, and the slaps or holes where they were
" placed in the cruive dyke left free and open; and declared that the
" defenders, in case they should contravene the regulations thereby
" established in time to come, should be liable to the pursuers in the
" sum of £50 sterling of damages for each contravention. By the said
" interlocutors it was found that the said Earl of Fife was entitled to
" withdraw water from the river at the cruive dyke by a lade for the
" purpose of driving the said Rack Mill belonging to his lordship, the
" entry to the mill-lade from the river to be two feet above the bed of
" the river. The said interlocutors were, on an appeal by the pursuers
" Lord Banff and others, affirmed by the House of Lords in the year
" 1781.

" 3. In or about the year 1780, the said Earl of Fife, having been
" charged under the said interlocutors, at the instance of Peter Garden
" of Delgaty and John Grant of Dunlugas, two of the pursuers in the
" said action, suspended the charge, and two actions were raised in the
" Court of Session at the instance of the Right Honourable William,
" Lord Banff, and certain other proprietors of upper fishings in said
" river, against the said Earl, and the tacksmen of his fishings, alleging
" that they had transgressed the terms of the foresaid interlocutors, in
" various ways therein mentioned, and were liable in the penalties
" therein concluded for. The three actions were conjoined, and, after
" proof, the Court of Session, by interlocutors dated 2nd August 1782,
" 21st January 1783, and 23rd February 1784, found that it had not
" been proved that there had been any alteration made on the cruive
" dyke since the decrees, dated 16th February and 8th December 1773,
" and 4th August 1774, above mentioned, nor any contravention of the
" regulations established by those decrees, and therefore sustained the

" defences of the Earl of Fife and his tacksmen, suspended the charge " made against him and his tacksmen, and assoilzied them from the " penalties libelled, with expenses of process.

" 4. By 'The Salmon Fisheries (Scotland) Act 1862' (25 & 26 Vict. " cap. 97, section 7), it is provided that 'the annual close time for every " 'district shall continue for 168 days; and the weekly close time, " 'except for rod and line, shall continue from the hours of six of the " 'clock on Saturday night till the hour of six of the clock on Monday " 'morning; but the Commissioners shall have power, on the applica- " 'tion of the District Board or of any two proprietors of fisheries in " 'any district, to vary the period at which the weekly close time shall " 'commence in any district or any part thereof, in so far as they may " 'think reasonable or expedient: Provided that such weekly close time " 'shall in no case be less than thirty-six hours.'

" 5. By section 6, sub-section 6, of the said Act, it is provided that " 'The Commissioners shall have the powers and perform the duties " 'hereinafter specified; that is to say * * * To make general " 'regulations with respect to the following matters, viz.:—

" 'The due observance of the weekly close time; the construction " 'and use of cruives; the construction and alteration of mill " 'dams or lades or water-wheels, so as to afford a reasonable " 'means for the passage of salmon; the meshes of nets (so that " 'they shall not intercept smolts or salmon fry); obstructions " 'in rivers or estuaries to the passage of salmon;

" 'Provided that such regulations shall not interfere with any rights " 'held at the time of the passing of this Act under Royal Grant or " 'Charter or possessed for time immemorial.'

" 6. By 'The Salmon Fisheries (Scotland) Act 1868' (31 & 32 Vict. " c. 123) it is enacted (section 10) that 'The bye-laws contained in the " 'schedules (A), (B), (C), (D), (E), (F), and (G), to this Act annexed, " 'shall in all respects be held to have been duly made and published, " 'but only in so far as consistent with and authorised by the recited " 'Acts' (viz. the said Act, 25 & 26 Vict. c. 97; 26 & 27 Vict. c. 50; " and 27 & 28 Vict. c. 118), 'and to such extent shall be as valid and " 'binding as if the same had been expressly enacted in this Act.'

" The schedule F of the said Act is in the following terms, viz.:—

"SCHEDULE F.

" *Bye-law.*

" '25 & 26 Vict. c. 97; 26 & 27 Vict. c. 50; 27 & 28 Vict. c. 118; " 'Acts to regulate and amend the law respecting the Salmon " 'Fisheries of Scotland.

" 'We, the commissioners appointed under the said Acts, and " 'empowered thereby to make general regulations with respect to the

" ' construction and use of cruives, do hereby make the following general
" ' regulations with respect to the construction and use of cruives :—

" ' I. The upper surface of the sill of each cruive shall not be higher
" ' than 12 inches above the natural bed of the river where the cruive
" ' is placed, and in the event of the sill being placed any higher than
" ' the natural bed of the river, there must be a paved floor or apron to
" ' it down stream at least as wide as the cruive, having its lower end
" ' not higher than the natural level of the river, and having a slope
" ' not steeper than 1 in 6, and otherwise the cruives shall be so con-
" ' structed as to afford a ready and easy passage for the fish during the
" ' annual and weekly close times.

" ' II. No cruive shall be less at any part of it than 4 feet broad in
" ' the clear; provided that where an upright post is used to support
" ' the cruive, thereby dividing the width into two parts, the aggregate
' ' width exclusive of such post shall not be less than 4 feet.

" ' III. The hecks or rails and inscales shall be capable of being
" ' removed from the cruive, and shall be removed during the annual
" ' close time. During the weekly close time the hecks or rails shall
" ' be removed, and the inscales shall either be removed or kept open for
" ' the space of 4 feet.

" ' IV. The bars of the upper hecks or rails shall be placed perpendicularly
" ' not less than 3 inches apart, and they shall not be more than 2 inches
" ' thick, and not more than 4 inches broad in the up and down way of
" ' the stream, and they shall have their edges rounded off, so that only
" ' 1½ inches in breadth of the whole thickness of 2 inches shall remain
" ' in the side of the hecks or rails in the up and down way of the
" ' stream.

" ' V. The bars of the inscales shall not be of larger dimensions than
" ' those of the hecks or rails, and they shall not be less than 2 inches
" ' apart.

" ' VI. Each side or half of the inscales shall not be less than 3 feet
" ' long for a cruive, 4 feet wide in the clear, and shall be longer in the
" ' same proportion to any additional width of cruive. They shall be
" ' constructed so that the up-stream ends cannot and shall not at any
" ' time approach nearer to each other than 5 inches.

" ' VII. No net or other contrivance whatever shall be placed or
" ' used on or at any cruive, or structure connected with a cruive, for
" ' the purpose of catching fish, or for preventing their entry into or
" ' passing through the same ; nor shall any device be employed to scare,
" ' deter, or obstruct fish from entering into or passing through any
" ' such cruive. But notwithstanding anything herein contained, it
" ' shall be lawful to place a canvas cloth or a wooden blind or blinds
" ' over the heck or hecks of a cruive whilst the fish are being taken out
" ' of it, provided such cloth blind or blinds be not applied longer than
" ' fifteen minutes at a time, or oftener than six times in the course of
" ' twenty-four hours, and that when there are more cruives than one at
" ' the same dam, only one cruive shall be covered by the cloth or blinds
" ' at the same time.

" 'VIII. No cruive shall be so constructed inclosed, roofed, or built " 'over, or in any other manner hidden or fenced in, as to prevent " 'persons duly authorised from inspecting the same at all times, and " 'ascertaining whether the law is being duly complied with.

" 'IX. No cruive shall be so altered as to create a greater obstruction " 'to the free passage of fish than at present exists.'

" 'Wm. J. Ffennell }
" 'Fred. Eden } *Commissioners.*
" 'James Leslie }

" 'Fisheries Department, Home Office,
" '18th day of April 1865.
" '*Approved.*

" 'Whitehall, 19th July 1865 G. Grey.

" '(This bye-law to take effect from the 28th July 1865).

" 7. At a meeting of the second party's Board, held on 30th June 1866, " the superintendent of the said Board reported that the said cruives " belonging to the first party were not in accordance with the bye-laws " above quoted. Mr. Hannay, factor for the then Earl of Fife's " trustees, who were then proprietors of the said salmon fishings and " cruives, stated that the cruives were in accordance with Lord Fife's " rights and his titles, and as possessed from time immemorial, and " were not subject, so far as regards their construction, to the operations " of the bye-laws. Whereupon Sir George S. Abercromby (an upper " proprietor) gave notice that at next meeting he would move 'that Mr. " 'Hannay be requested to produce for the satisfaction of the Board " 'the said rights, or a copy thereof.'

" The next meeting of the said Board was held on 28th September " 1866. The minute bears that 'Mr. Taylor, one of Lord Fife's " 'trustees, attended the meeting, and stated, on the part of the " 'trustees, that he would recommend Lord Fife to alter the inscales of " 'the present cruives, so as to harmonise with the bye-law, and this " 'though his Lordship's rights were fixed by decree of the Court of " 'Session, and that he would also recommend the races to be paved.' " The motion, of which notice had been given by Sir George S. " Abercromby, was not moved. The inscales of the cruives were there- " after altered so as to harmonise with the said bye-law, so far as that " could be done consistently with the maintenance of the width of the " cruive at an ell (which is equal to 37 inches), as fixed by the said " interlocutors of Court.

" 8. The first party and his predecessors, proprietors of the said " cruive dyke, cruives, and fishings, have uninterruptedly maintained, " under and in virtue of the said interlocutors of the Court, the three " cruives of the width of an ell (37 inches) each, in terms of the said " interlocutors. During the weekly close time, the inscales have been " taken out or removed in terms of the said interlocutors.

"9. By the 'Fishery Board (Scotland) Act 1882' (45 & 46 Vict. c. " 78), section 5, subsection 2, it is provided that 'the Fishery Board' " (being the Fishery Board for Scotland established by that Act), 'shall " 'have the general superintendence of the salmon fisheries of Scotland, " 'and shall have the powers and duties of Commissioners under the " 'Salmon Fishery Acts, but without prejudice to or interference with " 'the powers of District Boards.'

"In October 1894, the Fishery Board drew the attention of the " second party's Board to the bye-law Schedule F, above quoted, " in so far as it provided that no 'cruive shall be less in any part of " 'it than 4 feet broad in the clear,' and suggested that, in this respect, " the said cruives were not in conformity with the bye-law. The second " party submitted the communication for the observations of the first " party, and it was ultimately arranged that the parties should adjust a " special case for the opinion and judgment of the Court upon the " question of law at issue between them. The parties are agreed that " the widening of the cruives to the said breadth of 4 feet each would, " by lessening the pressure of water, assist the free passage of fish; but " if the said cruives are so widened, the first party's water supply for " Rack Mill above mentioned, his right to which was judicially affirmed " by the interlocutors above referred to, will, or may be, prejudiced " during the summer months. The first party estimates the annual " value of the Rack Mill, including the present water power, at £15.

"11. The first party maintains that, in virtue of his titles, and of the " decrees of Court above referred to, and of the proviso to section 6 of " the Salmon Fisheries (Scotland) Act 1862, above quoted, he is entitled " to maintain and continue to use the said cruives of the width, viz. not " more than an ell, or 37 inches, each in breadth, as fixed by the said " decrees, at which breadth the cruives have been from time immemorial " maintained; and that the said 10th section of the Salmon Fisheries " (Scotland) Act 1868, and relative bye-law, do not in any way alter or " abridge his said right. The second party, on the other hand, maintains " that, on a sound construction of the said Statutes and Schedule, the " first party is bound so to alter and construct the said cruives as to " bring them into conformity with the requirements of the said " Schedule."

The Lord President, in giving judgment, said :—

"The main question raised by this special case is whether the first " party is entitled to maintain and continue to use his cruives at their " existing size, which is 37 inches, or is bound to conform to the regulations of the Commissioners, which require cruives to be of the width " of 4 feet.

"Now, *de facto*, the Duke's cruives, 37 inches wide, have been there " for upwards of a hundred years; but then their origin is very clearly " shown in the special case. The first party does not ascribe the size of " the cruives to any specific provision to the effect in the Royal Charters " under which he is in right of the salmon fishings. On the contrary, " the size of 37 inches was laid down by the Court of Session in the " decree mentioned on record; and, from the terms of the decree, it is " clear that the court prescribed cruives of this size by way of equitably " harmonising the exercise of the rights of the Earl of Fife with the " interests of the upper riparian proprietors. In short, the provision of

" the 37 inch cruives was a regulation laid down by the Court of Session, " which was then the only body competent to do in particular cases " what is now done by the Commissioners through general regulations. " I do not think, therefore, that the first party can be said to have any " right to this particular size of cruive under his Charters, and I do not " think that the mere fact of the cruives having been there since 1774 " discloses a case of a right possessed for time immemorial in the sense " of the Act, especially when the origin of the cruives is seen to have " been a decree regulative of possession. The Act of 1862 introduces a " new system of regulation, and regulations made under it apply not " merely to structures to be erected in the future, but to existing structures, as was held in the case of Kennedy *v.* Murray. This being so, " I see nothing in the history of the cruives now under consideration " to afford to them any immunity from the regulations of the " Commissioners.

" A special point was made regarding the effect of widening the " cruives on the flow of water into the mill-lade. But I suppose the " necessary result of widening cruives is to affect the flow of the water; " and this is one of the incidental results of the regulations which must " be submitted to. Here, again, the first party has no special right conferred by Charter which places his mill-lades in a protected position. " The provision in the decree which relates to this matter is again of a " regulative character, confers no immunity, and does not denote any " right of the character which is safeguarded in the Act of 1862.

" I am, therefore, for answering the first question in the negative. " It was decided in the case of Kennedy that the cost of the operations " necessary to produce conformity with the regulations falls on the " proprietor; and, therefore, the second query should be answered in " the affirmative. This does not necessarily imply that the Board might " not be entitled, in case of failure on the part of the proprietor, themselves " to widen the cruives; and therefore, considered in the abstract, the " third query is not properly alternative to the second. But it is so " put, and no circumstances are stated as giving rise to it, except the " contention of the first party on the question of expense. Accordingly, " I think that we should hold it to be superseded."

Lord Adam said :—

" By section 6, sub-section 6, of the Fisheries Act of 1862, the Commissioners are directed to make general regulations with respect to, " *inter alia*, the construction and use of cruives, provided that such " regulations shall not *interfere* with any rights held under Royal Grant " or Charter, or possessed from time immemorial.

" The right of cruive fishing, and, so far as I know, all other rights " of salmon fishing, are exercised under conditions and regulations " imposed by Act of Parliament, or otherwise. Any alteration of such " conditions and regulations would in one sense be an interference with " such rights of salmon fishing. If that be the meaning of the Act, I " do not see how the Commissioners could make any regulations altering " or affecting the previously existing conditions and regulations, so that " would be interfering with the right of fishing.

"It appears to me, therefore, that regulations altering or modifying "the existing regulations are not in the sense of the Act interference "with the right of fishing, but merely with the mode and manner in "which such right shall be exercised.

"In this case one of the conditions or regulations under which the "Duke's right was exercised was that the cruive should be at least an "ell in height and an ell in breadth, that is 37 inches.

"One of the general regulations issued by the Commissioners requires "that no cruive shall be less than 4 feet broad in the clear. It appears "to me that this regulation does not interfere with the Duke's right of "fishing, but is merely an alteration of the conditions on which it is to "be exercised, and that his Grace is bound to conform to it.

"It is said, however, that if the cruives are so widened, his supply of "water to the Rack Mill may or will be prejudicially affected. It "appears to me, however, that his *right* to take water is not interfered "with by the regulations.

"I think that the first question should be answered in the "negative.

"I think the second and third questions should also be answered in "the negative. I think the Duke is not bound to widen the cruives "unless he pleases, and that the Fishery Board are not entitled to "widen them.

"The remedy is that if the Duke proceeds to fish with cruives of a "less breadth than 4 feet he may be stopped by interdict."

Lord M'Laren said:—

"I concur with your Lordship in the chair. We must assume that "the Commissioners have a statutory power of regulation, and there- "fore it is not an answer or good objection to a regulation of this kind "that the mode of enjoyment of the right of fishing is altered in some "respects—and nothing more, I think, has been said in this case. It "is substantially still a right of cruive fishing. At the same time it is "perfectly plain that the Commissioners cannot, under the guise of "regulation, take away or substantially diminish the rights of a "proprietor of salmon fishing; and it was for the purpose of safeguard- "ing these rights that the clause in question was inserted."

Lord Kinnear said:—

"I also agree with your Lordship. With reference to the last point "in Lord Adam's opinion, in which he pointed out that the remedy of "the Fishery Board, if the Duke of Fife's cruives do not conform to the "regulations, is not to compel him to make them conform, but to prevent "him fishing—to interdict his making use of the cruives. Now that "may be, but it does not appear to me that by answering the second "question in the affirmative we are deciding anything contrary to Lord

"Adam's view as to the proper mode of exercising the right of the "Fishery Board. That is not specifically raised in this special case. "The special case puts to us a question as to the rights and obligations "of parties; and, agreeing with your Lordship as to the obligation on "the Duke's right, I do not see that we should be called on at this "stage to consider how that obligation is to be enforced. On the whole "matter, therefore, I agree with the judgment which has been proposed "by your Lordship in the chair."

The second party was found entitled to expenses.

NOTE IV.—ABSTRACT of SUMS Raised and Expended

DISTRICT BOARDS OF RIVERS.	Rateable Value of the Fisheries.* 1.	RECEIPTS other than from Loans.				
		Assessments. 2.	Penalties and Expenses. 3.	Other Sources. 4.	TOTAL. 5.	
	£	£	£	£	£	
Alness, ...	584	169	.	.	169	1
Annan, ...	2,793	419	7	.	426	2
Awe, ...	896	112	11	.	123	3
Balgay, ...	20	.	3	45	48	4
Bervie, ...	536	107	.	.	107	5
Conon, ...	2,540	125	16	.	141	6
Cree, ...	554	42	.	8	50	7
Dee (Aberdeen), ...	14,593	1,021	6	.	1,027	8
Dee (Solway), ...	1,633	83	.	.	83	9
Deveron, ...	2,383	348	.	.	348	10
Don, ...	3,583	665	7	.	672	11
Esk (North), ...	6,812	376	3	1	380	12
Esk (South), ...	3,149	314	13	.	327	13
Findhorn, ...	3,501	330	.	.	330	14
Forth, ...	3,766	458	5	.	463	15
Girvan, ...	544	.	.	.	.	16
Kyle of Sutherland, . . .	2,611	228	1	.	229	17
Lochy, ...	2,122	9	.	†771	780	18
Nairn, ...	1,136	70	1	.	71	19
Ness, ...	3,209	321	18	.	339	20
Nith, ...	771	35	.	.	35	21
Spey, ...	9,588	1,039	11	.	1,050	22
Tay, ...	19,578	1,273	27	6	1,306	23
Torridon, ...	20	.	.	8	8	24
Tweed, ...	15,803	3,157	66	2	3,225	25
Ugie, ...	402	29	.	.	29	26
Ythan, ...	1,024	145	9	.	154	27
TOTAL, . .	104,151	10,875	204	841	11,920	28

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* This value is ascertained in terms of the Salmon Fisheries Act of 1862.
† Contribution from Lord Abinger.

by District Fishery Boards, during Year ended 15th May 1895.

	EXPENDITURE, not defrayed out of Loans.						LOAN TRANSACTIONS.		
	Wages and Salaries of Clerks, Constables, Bailiffs, Watchers, &c.	Loans.			Other Expenses.	Total.	Borrowed during the Year.	Loans outstanding at the close of the Year.	Sinking Fund at close of Year.
		Instalment repaid.	Payment into Sinking Fund.	Interest.					
	6.	7.	8.	9.	10.	11.	12.	13.	14.
	£	£	£	£	£	£	£	£	£
1	142	.	.	.	30	172	.	.	.
2	350	.	.	.	44	394	.	.	.
3	70	.	.	.	1	71	.	.	.
4	35	.	.	.	13	48	.	.	.
5	99	.	.	.	13	112	.	.	.
6	141	.	.	.	62	203	.	.	.
7	52	.	.	.	.	52	.	.	.
8	878	.	.	.	207	1,085	.	.	.
9	82	.	.	.	.	82	.	.	.
10	283	.	.	.	9	292	.	.	.
11	614	.	.	.	55	669	.	.	.
12	423	.	.	.	19	442	.	.	.
13	243	.	.	.	76	319	.	.	.
14	321	.	.	.	4	325	.	.	.
15	444	.	.	.	11	455	.	.	.
16	5	.	.	.	10	15	.	.	.
17	216	.	.	.	12	228	.	.	.
18	776	.	.	.	1	777	.	.	.
19	76	.	.	.	1	77	.	.	.
20	252	.	.	.	49	301	.	.	.
21	80	.	.	.	13	93	.	.	.
22	981	.	.	.	72	1,053	.	.	.
23	825	.	.	.	544	1,369	.	.	.
24	8	.	.	.	.	8	.	.	.
25	2,798	.	.	.	253	3,051	.	.	.
26	25	.	.	.	4	29	.	.	.
27	137	.	.	.	17	154	.	.	.
28	10,356	.	.	.	1,520	11,876	.	.	.

Note.—A blank return was received from the District Board of the river Stinchar, there being no receipts or expenditure.

NOTE V.

Rateable Value of Salmon Fisheries, in Districts where Boards have been formed, for the Years 1881 to 1895 inclusive.

YEAR.	Alness.		Annan.		Awe.		Balgay.		Bervie.		Conon.		Cree.		Dee (Aberdeen).		Dee (Solway).		Deveron.		Don.		Esk (North).		Esk (South).		Findhorn.	
	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1881	..	..	1,391	..	..	..	..	..	..	..	..	..	501	..	9,857	..	1,175	..	2,354	..	3,303	..	6,385	..	2,045	..	4,055	..
1882	..	..	1,719	..	..	..	..	..	..	..	..	..	522	..	9,556	..	1,195	..	2,575	..	3,025	..	5,942	..	2,200	..	3,493	..
1883	..	..	1,720	..	..	..	..	..	..	..	..	..	532	..	9,931	..	1,200	..	2,569	..	3,016	..	5,624	..	2,475	..	3,493	..
1884	..	..	1,864	..	..	..	..	..	..	..	..	..	530	..	10,504	..	1,200	..	2,549	..	3,499	..	6,349	..	2,546	..	3,501	..
1885	..	..	1,933	**1,725**	..	..	..	..	..	..	..	..	645	**546**	10,791	**10,127**	1,235	**1,201**	2,340	**2,477**	3,395	**3,247**	6,757	**6,211**	2,889	**2,431**	3,546	**3,617**
1886	..	..	1,998	..	..	..	..	..	..	..	..	..	530	..	10,805	..	1,565	..	1,790	..	3,588	..	7,216	..	2,934	..	3,546	..
1887	..	..	1,993	..	..	..	..	..	..	..	..	..	540	..	11,220	..	1,615	..	1,834	..	3,703	..	6,400	..	3,104	..	3,661	..
1888	..	..	2,007	..	..	..	..	..	..	..	..	..	530	..	12,532	..	1,517	..	1,865	..	3,908	..	6,419	..	3,124	..	3,551	..
1889	..	..	2,007	..	..	..	..	..	..	..	..	..	530	..	12,036	..	1,517	..	1,748	..	3,929	..	6,608	..	3,104	..	3,551	..
1890	..	..	2,107	**2,022**	701	..	40	..	585	..	2,624	..	530	**532**	12,274	**11,773**	1,627	**1,568**	1,800	**1,807**	3,905	**3,806**	6,725	**6,673**	3,012	**3,055**	3,541	**3,570**
1891	..	..	2,112		701	..	40	..	586	..	2,560	..	530	..	11,968	..	1,463	..	2,047	..	3,646	..	6,476	..	3,012	..	3,541	..
1892	..	..	2,099	..	718	..	40	.	586	..	2,756	..	530	..	12,336	.	1,463	.	2,071	..	3,623	..	6,519	..	3,012	..	3,501	..
1893	..	..	2,165	..	723	..	40	.	586	..	2,975	.	544	..	13,911	.	1,463	..	2,073	..	3,964	..	6,609	..	3,012	..	3,491	..
1894	579	..	2,778	..	723	..	40	..	536	..	2,944	..	554	..	14,489	..	1,463	..	2,138	..	3,743	..	6,812	..	3,002	..	3,501	..
1895	584	..	2,793	**2,389**	896	752	20	36	536	566	2,540	2,755	554	**542**	14,593	**13,461**	1,633	**1,497**	2,383	**2,142**	3,583	**3,711**	6,812	**6,645**	3,149	**3,037**	3,501	**3,507**

NOTE V.—(*continued.*)

RATEABLE VALUE OF SALMON FISHERIES, IN DISTRICTS WHERE BOARDS HAVE BEEN FORMED, FOR THE YEARS 1881 TO 1895 INCLUSIVE.

YEAR.	Forth.		Girvan.		Kyle of Sutherland.		Lochy.		Nairn.		Ness.		Nith.		Spey.		Tay.		Torridon.		Tweed.		Ugie.		Ythan.	
	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1881	3,793	..	574	..	2,762	..	1,582	..	..	..	3,075	..	568	..	10,563	..	21,698	..	..	..	13,477	..	322	..	746	..
1882	3,862	..	571	..	2,828	..	1,484	..	..	..	3,198	..	478	..	9,724	..	19,630	..	..	..	13,563	..	343	..	746	..
1883	3,896	..	571	..	2,388	..	1,873	..	..	..	3,285	..	499	..	8,654	..	19,223	..	..	..	13,745	..	339	..	790	..
1884	3,862	..	571	..	2,280	..	1,677	..	..	..	2,924	..	505	..	8,454	..	17,773	..	..	..	13,658	..	339	..	726	..
1885	3,931	**3,868**	571	**571**	2,222	**2,496**	1,677	**1,658**	..	..	3,030	**3,093**	553	**520**	8,430	**9,165**	19,656	**19,596**	..	..	13,557	**13,600**	334	**335**	726	**746**
1886	4,240	..	571	..	2,545	..	1,682	..	..	..	3,225	..	534	..	9,483	..	20,447	..	..	..	13,681	..	301	..	726	..
1887	4,382	..	542	..	2,558	..	1,749	..	..	..	3,239	..	515	..	9,559	..	22,542	..	..	..	14,382	..	290	..	816	..
1888	4,241	..	542	..	2,585	..	1,628	..	..	..	3,291	..	447	..	10,663	..	22,103	..	..	..	14,199	..	284	..	876	..
1889	4,187	..	542	..	2,610	..	1,866	..	..	..	3,185	..	402	..	10,663	..	19,701	..	..	..	14,254	..	351	..	876	..
1890	4,257	**4,261**	542	**547**	2,693	**2,598**	1,674	**1,719**	1,542	..	3,079	**3,203**	423	**464**	10,669	**10,207**	17,731	**20,504**	..	..	14,278	**14,158**	348	**314**	876	**834**
1891	3,890	..	542	..	2,640	..	1,895	..	1,543	..	3,366	..	443	..	9,669	..	17,820	..	40	..	14,414	..	358	..	931	..
1892	3,704	..	542	..	2,665	..	1,961	..	1,343	..	3,254	..	423	..	9,687	..	17,227	..	40	..	14,746	..	358	..	1,004	..
1893	3,765	..	542	..	2,613	..	1,961	..	1,343	..	3,253	..	756	..	9,687	..	19,008	..	40	..	14,573	..	358	..	1,004	..
1894	3,806	..	554	..	2,658	..	2,122	..	1,343	..	3,468	..	775	..	9,316	..	21,763	..	40	..	15,583	..	356	..	1,004	..
1895	3,766	**3,786**	544	**544**	2,611	**2,637**	2,122	**2,012**	1,136	1,341	3,209	**3,310**	771	**633**	9,588	**9,589**	19,587	**19,079**	20	36	15,803	**15,023**	402	**366**	1,024	**993**

NOTE VI.

ANNUAL CLOSE TIME APPLICABLE TO THE SALMON RIVERS IN SCOTLAND.

N.B.—Observe that, in the following List, the days fixing the commencement and termination of the Annual Close Time for Net-fishing and for Rod-fishing, respectively, are in all cases inclusive, as in the case of the Add, the first river in the List.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Add, ...	From Sept. 1 to Feb. 15, both days inclusive.	From Nov. 1 to Feb. 15, both days inclusive.
Aline, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Alness, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Annan, ...	From Sept. 10 to Feb. 24.	From Nov. 16 to Feb. 24.
Applecross, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Arnisdale (*Loch Hourn*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Awe, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Aylort (*Kinloch*), . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ayr, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Baa and Goladoir, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Badachro and Kerry (*Gairloch*), ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Balgay and Shieldag, .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Beauly, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Berriedale, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Bervie, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Bladenoch, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Broom, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Brora, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Carradale (*in Cantyre*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Carron, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Clayburn, Finnisbay, Avennangeren, Strathgravat, North Lacastile, Scalladale and Mawrig (*East Harris*), . . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Clyde and Leven, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Conon, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Cree, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Creed or Stornoway, and Laxay (*Island of Lews*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Creran (*Loch Creran*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Crowe and Shiel (*Loch Duich*), ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Dee (*Aberdeenshire*), . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Dee (*Kirkcudbright*), . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Deveron, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Don, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Doon, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Drummachloy or Glenmore (*Isle of Bute*), . .	From Sept. 1 to Feb. 15.	From Oct. 16 to Feb. 15.
Dunbeath, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Earn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Jan. 31.
Eckaig, ...	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Esk, North, ...	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Esk, South, ...	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Ewe, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Fincastle, Meaveg, Ballanachist, South Lacastile, Borve, and Obb (*West Harris*), . . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Findhorn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Fleet (*Sutherlandshire*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Fleet (*Kirkcudbrightshire*),	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Forss, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Forth, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Fyne, Shira, and Aray (*Loch Fyne*), . . .	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Girvan, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Glenelg, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Gour, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Greiss, Laxdale, or Thunga,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Grudie or Dionard, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Gruinard and Little Gruinard, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Halladale, Strathy, Naver, and Borgie, . . .	From Aug. 27 to Feb. 10.	From Oct. 1 to Jan. 10.
Helmsdale, . . .	From Aug. 27 to Feb. 10.	From Oct. 1 to Jan. 10.
Hope and Polla or Strathbeg,	From Aug. 27 to Feb. 10.	From Sept. 11 to Jan. 10.
Howmore, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Inchard, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Inner (*in Jura*), . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Inver, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Iorsa (*in Arran*), . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Irvine and Garnock, . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Kennart, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kilchoan or Inverie (*Loch Nevis*), ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kinloch (*Kyle of Tongue*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kirkaig, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kishorn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kyle of Sutherland, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Laggan and Sorn (*Island of Islay*), ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Laxford, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Leven, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Little Loch Broom, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Lochy, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Duich, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Luing, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Roag, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Lossie, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Luce, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Lussa (*Island of Mull*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Moidart, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Morar, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Mullanageren, Horasary, and Lochnaciste (*North Uist*), ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Nairn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Nell, Feochan, and Euchar,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ness, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Nith, ...	From Sept. 10 to Feb. 24.	From Nov. 15 to Feb. 24.
Orkney Islands (*River from Loch of Stenness, &c.*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Ormsary (*Loch Killisport*), Loch Head, and Stornoway (*Mull of Cantire*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Pennygowan or Glenforsa, and Aros, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Resort, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ruel, ...	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Sanda, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Scaddle, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Shetland Islands (*River of Sandwater, &c.*), . .	From Sept. 10 to Feb. 24.	From Nov. 16 to Jan. 31.
Shiel (*Loch Shiel*), . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Sligachan, Broadford, and Portree (*Isle of Skye*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Snizort, Orley, Oze, and Drynoch (*Isle of Skye*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Spey, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Stinchar, ...	From Sept. 10 to Feb. 24.	From Nov. 16 to Feb. 24.
Tay, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Jan. 14.
Thurso, ...	From Aug. 27 to Feb. 10.	From Sept. 15 to Jan. 10.
Torridon, Balgay, and Shieldag, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ugie, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Ullapool (*Loch Broom*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb 10.
Urr, ...	From Sept. 10 to Feb. 24.	From Dec. 1 to Feb. 24.
Wick, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ythan, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.

NOTE VII.

LIST OF CHAIRMEN AND CLERKS OF SALMON FISHERY DISTRICT BOARDS IN SCOTLAND.

DISTRICT.	Name and Address of Chairman.	Name and Address of Clerk.
Alness, . . .	Col. Alex. J. C. Warrand, Ryefield House, Conon Bridge, Dingwall.	William J. Duncan, Solicitor, Dingwall.
Annan, . . .	A. Johnstone Douglas, Esq., Comlongan Castle, Ruthwell.	John F. Cormack, Solicitor, Lockerbie.
Awe, ...	The Marquess of Breadalbane, Taymouth Castle, Perthshire.	Alex. MacArthur, Solicitor, Oban.
Ayr, ...	Richard A. Oswald, Esq. of Auchincruive, Ayr.	William Macrorie, Commercial Bank, Ayr.
Baa and Goladoir (Mull),	The Duke of Argyll, Inveraray Castle, Inveraray.	Alex. MacArthur, Solicitor, Oban.
Balgay, . . .	C. R. Manners, Esq., C.E., 12 Lombard Street, Inverness.	Duncan Shaw, W.S., 42 High Street, Inverness.
Bervie, . . .	David Scott Porteous, Esq. of Lauriston, as mandatory of the Commissioners of Woods and Forests.	Arthur Dickson, Solicitor, Montrose.
Broom, . . .	Sir Arthur George Ramsay Mackenzie of Coul, Bart., Coul House, Strathpeffer.	W. R. T. Middleton, Solicitor, Dingwall.
Conon, . . .	John Little Mounsey, Esq., W.S., 5 Thistle Street, Edinburgh, Commissioner for Col. J. A. F. H. Stewart Mackenzie of Seaforth.	Edmund J. Gunn, Solicitor, Dingwall.
Cree, ...	The Earl of Galloway, Cumloden, Newton-Stewart.	A. B. Matthews, Solicitor, Newton-Stewart.
Dee (Aberdeen),	The Lord Provost of Aberdeen.	Alex. Duffus, Advocate, Aberdeen.
Dee (Solway). .	H. G. Murray Stewart, Esq. of Broughton, Gatehouse.	W. Nicholson, Sheriff-Clerk, Kirkcudbright.
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NOTE VII. (*continued*)—LIST OF CHAIRMEN AND CLERKS OF SALMON FISHERY DISTRICT BOARDS IN SCOTLAND.

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Stinchar, . .	The Earl of Stair, Lochinch, Wigtownshire.	Thomas C. Greig, Rephad, Stranraer.
Tay, ...	Sir Robert Moncrieffe of Moncrieffe, Bart., Moncrieffe House, Perthshire, as mandatory for the Hon. F. J. Moncrieff, curator bonis of E. B Balfour Kay, Esq. of Mugdrum.	Mackenzie & Dickson, Solicitors, Perth.
Torridon, . .	C. R. Manners, Esq., C.E., 12 Lombard Street, Inverness.	Duncan Shaw, W.S., 42 High Street, Inverness.
Ugie, . . .	Lieut.-Col. Ferguson, of Pitfour, Mintlaw.	Robert Gray, Solicitor, Peterhead.
Ythan, . . .	Earl of Errol, Slains Castle, Aberdeenshire.	D. M. A. Chalmers, Advocate, Abedeen.
Tweed (Police Committee of the Commissioners),	Sir William Crossman, Cheswick, Beal, Northumberland.	James and David W. B. Tait, W.S., Kelso.

Note.—In addition to the districts specified above, the Duke of Sutherland is sole proprietor of the districts of the following rivers, viz. :—Helmsdale, Brora, Fleet, Kirkaig, Inver, Laxford, and Inchard (under the charge of his factor, Mr Donald M'Lean, Dunrobin Office, Golspie); and the Halladale, Strathy, Naver, Borgie, Kinloch, Hope, Polla or Strathbeg, and Dionard or Grudie (under the charge of his factor, Mr John Box, Tongue); and the Countess of Cromartie is sole proprietrix of the district of the river Kennart (under the charge of her factor, Mr William Gunn, Cromartie Estate Office, Strathpeffer).

Fishery Board for Scotland,
Edinburgh, 11th February 1898.

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SIXTEENTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE
LORD BALFOUR OF BURLEIGH
Her Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 1*st May* 1898.

MY LORD,

In continuation of our Sixteenth Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

IN this part of the Sixteenth Annual Report will be found an account of the principal scientific investigations conducted by the Board during 1897, in connection with the sea fisheries of Scotland. In the course of the year the investigations, which were carried on under the supervision of the Scientific Superintendent, were prosecuted on the same general lines as in previous years, and have resulted in further extensions of knowledge respecting the life-history and habits of the food fishes and the marine invertebrate fauna. Besides the researches, the results of which are set forth in this Report, a number of other enquiries have been in progress, but are not yet concluded. Among these may be mentioned the migration of the herring in Loch Fyne and the Firth of Clyde, the action of the seine-net for herrings in the capture of immature fish and the alleged destruction of spawn, the life-history of the edible crab, and the demarcation of the spawning areas in the Moray Firth.

A considerable part of the scientific enquiries have been carried on by means of the 'Garland,' the small steamer which the Board possesses for this work. As explained in previous Reports, the small size of this vessel has restricted the area and the scope of the scientific investigations, which have for the most part been confined to the territorial seas and to the firths and bays. Owing to this circumstance it has been scarcely possible to extend the enquiries to the off-shore waters, so as to ascertain the position and limits of the breeding grounds of the food fishes, and the biological and physical conditions of the great fishing banks in the North Sea. It is in this direction and to this area that we must look in future for the greatest advances in the scientific knowledge of fishery problems.

It is anticipated that the concentration of the scientific staff at Aberdeen, to be presently referred to, will facilitate the acquirement of this knowledge, inasmuch as that port possesses a large number of steam fishing vessels frequenting all parts of the North Sea, which may be in some measure utilised for the purpose. But it is obvious that without a suitably equipped steamer, under the direct control of the Board, to be systematically employed in the manner indicated, such investigations must continue to be both tardy and imperfect.

It may be stated that the Lancashire Sea Fisheries Committee are in possession of a steamer, superior to the 'Garland,' which is exclusively employed in fishery work, and that the Government of the Cape of Good Hope have had a high-class trawler built and specially equipped for conducting scientific investigations in connection with the fisheries of the Colony.

THE INFLUENCE OF TRAWLING.

The results of the trawling experiments carried on in 1897, together with the various Tables embodying the results of the observations, are given in a special report (p. 17). In 1896 the trawling investigations were suspended in the Firth of Forth and St. Andrews Bay, since which they have been conducted in the Moray Firth and the Firth of Clyde. For the reason previously referred to, the examination of the stations in each of these areas, especially those lying off-shore, has been necessarily imperfect, and sufficient information has not yet been acquired to enable a definite statement to be made as to the results, or the position and extent of the breeding grounds and habitats of immature fishes within their limits.

So far as the observations go, they show that in the Moray Firth the average number of flat-fishes taken in each haul of the trawl increased from 102·7 in 1896 to 149·0 last year; the increase being principally in dabs, but also in plaice. The general average for round-fishes, comprising cod, haddocks, whiting, and gurnard, diminished from 49·4 in 1896 to 32·8 last year, the decrease having occurred chiefly in haddocks and gurnards. In the Firth of Clyde the trawling experiments show that the average number of flat-fishes captured in each haul of the net increased in almost each successive year since the observations were begun. In 1888 the general average was 61·2, and it was the same on the next occasion when all the stations were examined, namely in 1890; in 1895 the average was 64·7, in 1896 it was 75·5, while last year it rose to 84·8. Amongst round-fishes greater fluctuations took place in the average number captured. In 1888 it was 44·7, in 1890 and 1896 it was 35, in 1895, 43·6, and last year 27·8. The increase of flat-fishes in the Clyde area was principally in witch-flounders and dabs; plaice increased but slightly.

The special statistics which have been collected during the past four years as to the quantities of fish caught by line-fishermen in the closed waters of the Moray Firth are of considerable interest. The following figures show the total quantity so taken, and the average weight of fish captured per 'shot' of the lines, in each of the districts for the four years:—

District.	1894.		1895.		1896.		1897.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Wick, - -	19,008	2·47	23,009	4·03	31,556	5·40	44,258	6·16
Lybster, - -	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22
Helmsdale, -	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·93
Cromarty, -	21,346	3·07	19,193	29·3	15,317	2·51	14,736	2·48
Findhorn, -	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66
Buckie, . -	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77
Banff, - -	49,292	2·94	76,491	4·77	66,471	3·82	61,329	3·701
Total, -	218,494	3·05	258,590	4·43	256,916	4·26	241,350	3·83

When these figures are compared with the figures given in the ordinary statistical Tables published in Part I. of the Board's Reports, showing the total quantities of white fish (exclusive of herrings, mackerel, and sprats) landed in each of the districts named, irrespective of the place of capture, it will be found that over 80 per cent. of the total quantity landed is taken from the closed waters of the Moray Firth. In the Wick district, which contains only a small part of the coast of the Moray Firth, while it comprises the northern coast of Scotland from Duncansby Head to Cape Wrath, the total quantity of white fish landed last year amounted to 88,440 cwts., of which 44,258 cwts., or almost exactly half, were caught by line-fishermen in the Moray Firth. All the line-caught fish landed in the districts of Lybster, Helmsdale, Cromarty, and Findhorn are returned as having been captured in the closed waters. In Buckie district, out of a total of 54,629 cwts. landed, 50,067 cwts. were taken in the Moray Firth; and of a total of 61,476 cwts. landed in the Banff district, 61,329 cwts. were drawn from the same area.

The number of 'shots' of the great line made in the closed waters has considerably increased during the period indicated. In 1894 they amounted to 7082, while last year they were 14,039, or very nearly double. The 'shots' of the small-line boats, on the other hand, have diminished in the same time from 54,866 to 48,836.

With respect to the fluctuation in the quantities of fish taken by line in the closed waters in the various years, it will be seen from the figures quoted above that both the total quantity captured and the average per 'shot' of the lines were less in 1897 than in the previous year, and that a diminution also occurred in 1896 as compared with 1895. That observation refers to the area taken as a whole. In two of the districts, Wick and Lybster, there was an increase. The increase in the Wick district amounted to 10,702 cwts., the average per 'shot' having risen from 5·40 cwts. in 1896 to 6·16 cwts. in 1897; the quantity landed in the Lybster district rose from 4241 cwts. in 1896 to 7192 cwts. in 1897, the respective averages in the two years being 2·87 cwts. and 4·22 cwts. The rise in both these districts is probably chiefly accounted for by the larger number of great-line boats taking part in the fishing. In the Wick district, for example, the number of 'shots' made by the large boats in 1896 was 2774, while last year it was 3911; in 1894 the number was only 396. On the other hand, the districts of Helmsdale, Cromarty, Findhorn, Buckie, and Banff show a falling off, although the decrease in the catch per 'shot' is not as a rule large. But although the quantity of fish caught by line in the Moray Firth was less in 1897 than in either of the two preceding years, it was considerably greater than in 1894, when the total only amounted to 218,494 cwts.

Examination of the statistics with reference to the kinds of fish which were caught by line shows that the diminution in 1897 was chiefly in the quantity of haddocks landed. The full details for each year are as follows:—

FISH.	1894.		1895.		1896.		1897.	
	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.
Cod	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26
Ling	2,169	0·035	2,937	0·005	3,868	0·062	3,544	0·056
Torsk	25	0·002	24	—	94	—	25	—
Saithe	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18
Haddock	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004
Whiting	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052
Turbot	5	—	—	—	15	—	16	—
Halibut	254	0·004	403	0·007	691	0·011	707	0·011
Lemon Sole	—	—	—	—	19	—	14	—
'Flounder, Plaice, and Brill'*	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063
Conger	1,244	0·02	777	0·013	823	0·013	1,533	0·024
Skate,	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063
Other kinds of White Fish	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105

* The fish included under this head comprise, for the most part, plaice and dabs.

It will be observed that the quantity of haddocks caught in the closed waters was less last year by about 30,000 cwts. than in the preceding year, and 52,000 cwts. less than in 1895, when this fish was exceptionally abundant. The quantity of cod landed in 1897 shows an increase of 15,000 cwts. over the previous year, and of 47,000 cwts. over the quantity caught in 1894. Apart from natural variation the fluctuations in the quantities of cod and haddocks landed are correlated, on the one hand, with the increase in the number of the shots of great-line boats, by which the former are almost exclusively captured, and on the other with the decrease in the number of shots by the small boats, which for the most part capture haddocks.

The Hatching and Rearing of Food-Fishes.

The operations at the Dunbar Hatchery for sea-fishes during last year consisted in the hatching of plaice, and in experiments on the rearing of plaice, turbot, and lemon soles. Adult plaice, to serve as spawners, were collected from trawlers in February and March, and a little over 600 males and females were placed in the spawning pond. Fertilised eggs were first observed towards the end of February, and from that time until 11th May 30,960,000 eggs were collected and transferred to the hatching apparatus. Of these, about 95 per cent. were successfully hatched, and the bulk of the fry, over 21,000,000 in number, were transported to Loch Fyne in April and May, and liberated in the waters of the loch at various places between Otter Spit and Strachur.

The numbers of the various species which have been hatched at the establishment and liberated in the sea since the work was begun are as follows :—

	Plaice.	Cod.	Lemon Soles.	Turbot.	Others.	Total.
1894	26,060,000	500,000	...	...	...	26,560,000
1895	38,615,000	2,760,000	4,145,000	3,800,000	1,050,000	50,370,000
1896	11,350,000	750,000	1,580,000	1,360,000	950,000	15,990,000
1897	24,370,000	...	...	...	...	24,370,000
	100,395,000	4,010,000	5,725,000	5,160,000	2,000,000	117,000,000

It was pointed out in several preceding Reports that the hatching work had been much impeded by the absence of sea-water enclosures in which the adult fishes, to serve as spawners, could be gradually collected, and retained from one season to another. It was therefore necessary to procure a fresh supply of living fishes each year before the spawning season began, and this course has, up to the present, been followed, the fishes being obtained from trawlers and transported to the hatchery by the 'Garland.' Besides involving considerable direct expenditure, and interrupting the ordinary work of the 'Garland,' this method of obtaining the breeding stock has serious disadvantages. A large proportion of the adults, which are distended with developing eggs, are injured in the unavoidably rough process of capture by trawl-nets, and most of these subsequently die shortly after they are placed in the spawning pond. Moreover, experience has shown that those ripe fishes which escape injury in this way require a certain time in which to become accustomed to confinement before they will shed their eggs. The spawning is under the control of the parent, and in such cases retention of the eggs in the gravid female not only leads to paralysis of the mechanism of oviposition and the loss of the eggs, but frequently causes the death of the fish. From these circumstances the quantity of fertilised eggs hitherto obtained at Dunbar has been much below what it would have been under more favourable conditions.

The formation of a large tidal enclosure in which the adult fishes might be retained from one season to another was an integral part of the plan adopted by the Board when the present hatchery was erected, and the Magistrates and Council of Dunbar granted the use of a creek at the mouth of the harbour there for the purpose. It was, however, found subsequently that the enclosure of this creek might endanger the safety of fishing boats making for the harbour in stormy weather, and the Burgh Authorities withdrew their consent.

The alternative had then to be considered whether the fish-hatching operations should be continued under the existing unsatisfactory conditions, or abandoned altogether, or whether another site should be chosen where a suitable tidal enclosure could be constructed. It was decided to adopt the latter course, and a site was selected in the Bay of Nigg, close to Aberdeen. The Corporation of Aberdeen, to whom the ground belongs, courteously granted a lease of the site to the Board at a nominal rent; plans were prepared by Mr. Rust, the City Architect, and the work is now in progress. The tidal enclosure will consist of a concrete tank ninety feet in length by thirty-five feet in breadth, and with an average depth of seven and a half feet. It will be sunk in the ground deep enough to allow it to be filled daily, if desired, by the flow of the tide, the water being admitted through a twelve-inch pipe. At the end of this season's hatching operations, the wooden hatchery at Dunbar, with the apparatus, pumps, and plant, will be removed to the Bay of Nigg.

In deciding to remove the fish hatchery to Aberdeen it was also deemed desirable to establish a marine laboratory at the same place, so that the scientific staff might be concentrated at one station, and the two branches of work carried on together under the supervision of the Scientific Superintendent. In coming to this decision consideration was given to the fact that special facilities exist at Aberdeen for the prosecution of scientific fishery research. As the chief fishing port in Scotland it possesses a large fleet of steam fishing vessels, both trawlers and liners, as well as herring boats, and opportunities will thus be afforded for the study of the life-history of fishes and marine biology generally. At the same time, chiefly by means of the 'Garland,' other investigations will be carried on as heretofore in the Moray Firth and the Firth of Clyde.

RESEARCHES ON THE DEVELOPMENT AND MATURATION OF THE EGGS OF FISHES.

In several of the preceding Reports of the Board numerous papers have been published dealing with the description of the floating eggs of the food fishes and the development of the embryo. It is now well established that the eggs of all the important edible fishes, with the exception of the herring, are buoyant or pelagic; and may be carried considerable distances by the movement of currents. In the present Report Dr. Wemyss Fulton, the Scientific Superintendent, describes the growth and development of the ovarian eggs of teleostean fishes, belonging both to the pelagic and the demersal varieties, of which he gives a summary, as follows:—'The investigation deals mainly with the 'later stages in the ovation development of the teleostean ovum, 'especially the maturation of the pelagic ovum, and with certain 'phenomena which arise in consequence of the changes which occur. 'The most important point which has been determined is that the 'final change in the maturation of the pelagic ovum, while still 'within the ovary, is accompanied by a comparatively rapid and 'relatively great accession of a watery fluid, of low density, secreted 'by the follicle, which dissolves the yolk-spherules, is associated 'with the dissolution of the germinal vesicle, and the definite formation of the germinal layer; distends the ovum to three or four 'times its former volume, thinning the capsule correspondingly, 'renders it of crystalline transparency, and reduces its specific 'gravity so that it is enabled to float in sea-water of ordinary density—in other words, to become pelagic. The fact has also been 'established that this change likewise occurs in the demersal eggs of 'Teleosteans at maturation, but to a less extent, the quantity of fluid 'absorbed being much smaller in amount, and the yolk-spherules 'remaining comparatively little affected.

'The process is different from the ordinary slow growth of the 'eggs within the follicle. It is a more rapid physical or physico-'chemical change, the fundamental function of which is probably 'the partial solution of the yolk, the dissolution of the germinal 'vesicle, and the rearrangement of the chromatin—the phase marking the completion of ovarian growth and the preparation of the 'egg for fertilisation—but which has, so to speak, been specially 'developed for another purpose—namely, to enable the eggs to 'float and to become widely dispersed.

'The discovery of the dilution of the nutritive yolk by several 'times its volume of water explains a number of phenomena hitherto 'obscure in the development of the embryo of pelagic eggs, such as 'its comparatively brief duration, the absence of true vitelline circulation, the simple mode by which the yolk is absorbed, the rapidity 'with which it is absorbed in the larval stage, and the relatively small 'and ill-developed condition of the larva. It is obvious that, since 'the substance of the embryo and larva is almost entirely derived 'from the yolk, an egg in which the yolk has been diluted with three 'or four times its bulk of watery fluid has only a third or a fourth 'of the nutritive power of one in which the yolk remains in its 'original state; and that, other things being equal, the physiological 'transformation of yolk into embryo ought, in such a case, to be both 'more rapid and easy, and the resulting embryo either smaller or less 'developed or both. In this sense, so far as concerns nutritive value, 'the mature demersal egg is comparable, not to the mature pelagic 'egg, but rather to the preceding opaque stage; although the initial 'nutritive value of the latter, unit for unit, is in reality inferior.

'A knowledge of the nature of the yolk in pelagic eggs likewise 'explains the gradual sinking of the larvæ after they are hatched, 'and even in some cases of the egg containing the advanced embryo. 'It is in virtue of the watery yolk of low specific gravity that the 'egg floats, and as this becomes used up in the growth of the little 'fish, to which it is attached, and transformed into its denser tissues, 'the specific gravity of the whole is increased, until it exceeds that

‘ of the sea water in which it is immersed. Hence the general rule ‘ that pelagic eggs are obtained in the surface layers of the sea, while ‘ the larvæ are found most abundantly towards the bottom and in ‘ the middle layers. The expansion of the pelagic ovum at matur- ‘ ation to three or four times its previous size is also correlated in ‘ certain important respects with the life-history of the species.

‘ Inasmuch as the entrance of fluid into demersal eggs can have ‘ no hydrostatic function, it is highly probable that the same change ‘ is of normal occurrence in many other groups, such as the mam- ‘ malia, and is associated with the disappearance of the germinal ‘ vesicle.’

In order that the chemical changes which occur in the processes described might be as far as possible elucidated, the Board appointed Dr. T. H. Milroy, of the Physiological Department of the University of Edinburgh, to make a research on the subject, and his report is also published in the present volume. It is shown that among pelagic eggs the quantity of water present rises during maturation from about seventy to over ninety per cent. of the total contents, while among demersal eggs it rarely rises over seventy per cent.; and the quantity is constant in the eggs of a particular species. It is also shown that besides the absorption of water there is a considerable increase in the salts during maturation; and a description is given of many hitherto obscure points in the chemistry of the egg.

Also in connection with this branch of fishery research, Mr. H. Ch. Williamson, M.A., B.Sc., has made a study of the absorption of the yolk, and the primitive circulation in the pelagic eggs of fishes, especially in the haddock, whiting, flounder, hake, anchovy, and murænoids, in which it is shown that a modified vitelline circulation of yolk corpuscle occurs. The respiratory processes in the embryo of teleostean fishes is also described, and illustrated in two plates.

In another paper Dr. Fulton gives an account, with figures, of the hitherto undescribed ovaries of the angler or monk-fish and the John Dory, together with a description of the ovarian eggs.

THE POST-LARVAL STAGES OF FLAT-FISHES.

In the present Report Mr. H. M. Kyle deals with a subject which is frequently of considerable practical importance in fishery questions, namely the identification of flat-fishes in their very young stages. It is often a matter of much difficulty to identify such young forms living on the beaches or in shallow water, and thus the young of worthless species may be confounded with those of valuable edible forms. Mr. Kyle has made a comparative study of a large number of specimens of the post-larval stages of the plaice, dab, flounder, long rough dab, and lemon sole, and has carefully described their differential characters and represented them in a series of figures.

SEINE-NET FISHING FOR HERRINGS.

The question of the alleged injurious action of the seine-net in fishing for herrings on the West Coast was made the subject of an investigation, which is not yet completed. The two chief objections raised against this mode of fishing are that it wastefully destroys the spawn of herrings which has been deposited on the bottom, and captures and destroys large quantities of immature herrings. For some years in succession arrangements have been made to carry on an investigation on the former point at the well-known spawning ground at Ballantrae Bank, but on each occasion the fishing has been so poor that the seine-net boats did not take part in it. During last summer an enquiry was begun in Loch Fyne with reference principally to the action of the seine-net in capturing immature herrings, and the catches of several hundreds of seine-net boats were examined and the condition of maturity of large numbers of the smallest herrings determined. This investigation will be completed during the ensuing season.

As will be seen by a reference to the statistics in Part I. (p. 117), the herring fishing last year in Loch Fyne was exceptionally abundant.

THE PELAGIC FAUNA OF THE FIRTH OF FORTH AND LOCH FYNE.

In an elaborate paper Mr. Thomas Scott, F.L.S., gives the results of a study of the distribution of the pelagic fauna of the Firth of Forth and its vicinity, founded upon his observations on board the 'Garland' during the seven years from 1889 to 1895. He deals with the various groups of invertebrates captured in the tow-nets, most fully with the Crustacea, and also with the pelagic eggs of the food fishes. The distribution of some of the most typical species at several selected stations during the various months of the year has been very carefully investigated, the results being indicated in a series of tables and graphic charts. Among many points of interest elucidated is the fact that in March and April the waters begin to swarm with the larvæ of crustaceans, which form a most important part of the food of young fishes, and that this abundance of fish-food is maintained throughout the summer by the successive spawning of different species of crustaceans. Mr. Scott has also supplemented his investigations on the invertebrate fauna of Lochfyne by a paper in the present Report, in which he describes a number of new species, etc., especially of Crustacea.

THE INVERTEBRATE FAUNA OF INLAND WATERS.

In order to determine the seasonal variations in the invertebrate fauna of inland waters Mr. Scott has made periodical examinations of a number of Scottish lochs, including Loch Lomond, Loch Katrine, and Loch Achray, and has also investigated the fauna of several of the lochs in the Shetland Isles. In the present Report he describes the results of the latter enquiry and also furnishes descriptions of a number of new species which he has discovered.

We have the honour to be,

Your Lordship's most obedient Servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
JOHN MURRAY.
J. RITCHIE WELCH.
W. R. DUGUID.
ARCHIBALD JAMESON.
L. MILLOY.

WM. C. ROBERTSON, *Secretary.*

SECTION A.—GENERAL REPORTS.

I.—REPORT ON THE TRAWLING EXPERIMENTS OF THE 'GARLAND,' AND ON THE FISHERY STATISTICS RELATING THERETO.

INTRODUCTORY.

During the year 1897 the trawling operations of the 'Garland' were for the most part conducted in the Moray Firth and in the Firth of Clyde. The number of hauls of the trawl made in these areas was 114, the stations having been examined in April, May, June, September, and November. The work at each station consists (1) in trawling along a selected line for a specified distance, all the fish caught being carefully enumerated, measured, and recorded; (2) observations on the temperature, salinity, and transparency of the water, and on the condition of the weather and sea; (3) determination of the invertebrate fauna living on the bottom, which constitutes the principal food of the fishes caught in the net; (4) volumetric and specific determination of the pelagic fauna floating in the water. The Tables relating to these investigations are appended to this Report. In addition, investigations have been made on the distribution of pelagic eggs and larval fishes by Mr. H. Ch. Williamson, and on the distribution of immature and spawning fishes.

The 'Garland' was also employed, in connection with the sea-fish hatchery at Dunbar, in procuring adult flat-fishes and in the transportation of the fry, and in making enquiries into the herring fishing in Loch Fyne.

The statistics which have been collected in connection with the trawling experiments in the Moray Firth, showing the quantities of the various kinds of fish caught by line fishermen within the closed waters in each month of the year and for the whole year, are appended to this Report and are discussed below. These statistics were collected by the fishery officers of the respective districts, or by their correspondents. The trawling records were made by Mr. Thomas Scott, F.L.S., and by Mr. F. G. Pearcey; occasionally by Captain Campbell, in command of the 'Garland.'

1. THE TRAWLING EXPERIMENTS IN THE MORAY FIRTH.

The means taken to ascertain the influence of the closure of this area to beam trawlers on the abundance of the food fishes within it have consisted, first, of trawling observations of the 'Garland' at the sixteen stations, inshore and offshore; and, secondly, the collection of special statistics around the coast to show, as far as possible, the quantities of the various kinds of fishes caught by line fishermen within the closed area in each month of the year, and the number of 'shots' of the lines by which these fishes were captured. The fish caught by trawl consist, for the most part, of flat-fish, while those taken by hook are principally round-fish. During last year the stations were examined in June and November, 32 hauls being made. So far as the results go they show that the average numbers of flat-fishes captured per haul of the net at each of the stations were as follows:—

FLAT-FISHES.

Station.	Plaice.	Lemon Soles.	Witch Soles.	Common Dab.	L. Rough Dab.	Turbot.	Brill.	Total.
1	37·5	3·5	10·0	50·0	8·0	...	...	109·0
2	26·0	2·0	26·0	75·5	28·5	...	0·5	158·5
3	37·5	6·0	...	4·5	...	...	...	48·0
4	45·5	...	...	15·0	...	...	...	60·5
5	57·0	2·0	...	87·5	0·5	...	0·5	148·5
6	71·0	7·5	...	134·0	2·0	...	...	215·0
7	2·0	8·5	0·5	319·0	46·0	...	...	376·0
8	4·5	10·5	1·0	206·0	44·0	...	...	266·0
9	2·0	12·5	1·0	175·0	51·5	...	...	242·0
10	2·0	4·5	24·0	40·0	65·5	...	...	136·0
11	3·5	5·0	...	101·0	...	...	...	109·5
12	6·5	4·5	...	117·0	0·5	...	...	128·5
13	5·5	11·5	...	41·0	0·5	...	...	59·0
14	2·5	7·5	...	59·0	16·0	...	...	85·0
15	6·0	6·5	...	150·5	23·5	...	...	186·5
16	6·0	13·0	...	27·0	11·0	...	...	57·0

When compared with the corresponding returns for 1896 these figures show a general increase of flat-fishes, the average per haul over the whole area being 149·0 as against 102·7 in the previous year. The largest increase is shown in common dabs and plaice, the figures for the former in the two years being 66·4 and 100·2 respectively, and those for the latter 11·9 and 19·7. The average number of round-fishes, comprising cod, haddock, whiting, and gurnard, varied from 12·5 to 80·5 at the different stations, the general average for the whole area being 32·8, as against 49·4 in the previous year, showing, therefore, a decrease, which was chiefly in haddocks and gurnards. The data are at present insufficient to enable anything more than a transient conclusion to be drawn.

Information is also being accumulated, as far as the means permit, with respect to the determination of the breeding or spawning grounds in the Moray Firth, and the distribution of immature fish throughout the area at different seasons; and it is hoped that sufficient information will be acquired to enable a report on this subject to be prepared in the near future.

The special statistics of the fish caught within the closed area of the Moray Firth by line fishermen have been collected for the past four years.

The total quantity of fish caught and the average catch per 'shot' in the various districts for each of the years is as follows :—

District.	1894.		1895.		1896.		1897.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Wick, - -	19,008	2·47	23,009	4·03	31,556	5·40	44,258	6·16
Lybster, - -	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22
Helmsdale, -	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·93
Cromarty, -	21,346	3·07	19,193	2·93	15,317	2·51	14,736	2·48
Findhorn, -	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66
Buckie, - -	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77
Banff, - -	49,292	2·94	76,491	4·77	66,471	3·82	61,329	3·701
Total, -	218,494	3·05	258,590	4·43	256,916	4·26	241,350	3·83

It is interesting to compare the figures given in this Table with the figures showing the total quantity of the same kinds of fish landed in each district, and caught both within and without the closed area.

Thus, excluding herrings, sprats, and mackerel, which are not comprised in the special statistics referred to, the total quantities, in cwts., of white fish landed in each of the districts in 1897 were as follows :—

Wick.	Lybster.	Helmsdale.	Cromarty.	Findhorn.	Buckie.	Banff.
88,440.	7,118.	17,148.	14,736.	46,694.	54,629.	61,476.

When these figures are compared with those given above, it will be seen that almost all the line-caught fish landed in those districts are taken from the closed waters of the Moray Firth. The Wick district comprises only a comparatively small part of the coast of the Moray Firth, while it includes the north coast of Scotland as far as Cape Wrath; and the totals for the whole district are, of course, derived from the whole extent of coast within its limits. Yet almost exactly half of the total quantity of line-caught fish landed in the district is drawn from the Moray Firth. All the line-caught fish landed in the districts of Lybster, Helmsdale, Cromarty, and Findhorn are returned as having been captured in the closed waters of the Moray Firth. In Buckie district, out of a total quantity of 54,629 cwts. landed, 50,067 cwts. are returned as taken from the closed area; and of a total of 61,476 cwts. of line-caught fish landed in the Banff district, 61,329 cwts. were taken within the same area.

With respect to the increase or decrease in the quantities taken by line in each year in the closed waters, it will be noticed from the foregoing Table that both the total quantity caught, and the average per 'shot' of the line, were less in 1897 than in 1896, and that a similar diminution occurred in 1896 as compared with 1895. That observation refers to the area taken as a whole. In two of the districts there was an increase, and indeed an almost continuous increase since 1894, in the quantity of fish landed. These districts are Wick and Lybster, which are situated on the coast of Caithness, in the northern part of the area; the districts in the central part and on the south coast show a decrease both in the total quantity caught and in the average catch per 'shot.' The increase in Wick district amounted to 10,702 cwts., the average per 'shot' having risen from from 5·40 cwts. in 1896 to 6·16 cwts. in 1897; the quantity landed in the Lybster district rose from 4241 cwts. in 1896 to 7192 cwts. in 1897, the respective averages in the two years being 2·87 cwts. and 4·22 cwts.

On the other hand, the districts of Helmsdale, Cromarty, Findhorn, Buckie, and Banff each showed a decrease, although the falling-off in the average catch per 'shot' is not as a rule large. At Helmsdale and Cromarty the diminution in the total quantity landed was trifling, while a slight increase in the average per 'shot' occurred at Helmsdale, and an equally slight decrease in the average at Cromarty. At Findhorn the decrease in quantity amounted to 16,836 cwts., the totals for the two years being 63,521 cwts. in 1896, and 46,685 cwts. in 1897. The average catch per 'shot' fell from 4·46 cwts. to 2·66 cwts. At Buckie there was a decrease of about 7000 cwts., and at Banff a decrease of about 5000 cwts., but the diminution in the average catch was not large.

If we now turn to the operations of the boats which prosecuted line fishing in the closed area, we shall find that while the number of 'shots' made by the small boats remained practically stationary—there having been only a trifling increase—the number of 'shots' of the large boats increased considerably, and this has been the tendency yearly since the statistics were begun, as the following Table shows:—

Year.	Wick.		Lybster.		Helmsdale.		Cromarty.		Findhorn.		Buckie.		Banff.	
	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.
1894	396	7,295	22	876	199	4,288	83	6,871	3,132	10,544	2,422	9,104	828	15,888
1895	1,553	4,155	90	965	366	3,614	12	6,561	2,653	11 481	1,929	8,907	1,107	14,930
1896	2,774	3,063	208	1,266	363	3,535	13	6,078	3,772	10,450	2,935	8,420	1,850	15,534
1897	3,911	3,266	264	1,440	466	3,010	3	5,918	4,738	12,810	2,537	7,943	2,120	14,449

The total number of 'shots' made by great-line boats and by small-line boats in the Moray Firth, as a whole, in each of the four years—1894–1897—are as follows:—Large boats, 7082, 7710, 11,915, and 14,039; small boats, 54,866, 50,643, 48,346, and 48,836. The number of 'shots' made by the great-line boats in 1897 was greater than in 1896 in all the districts except Cromarty and Buckie; the increase was most marked in the Wick and Findhorn districts. On the other hand, the number of 'shots' made by the small-line boats increased in the Wick, Lybster, and Findhorn districts, and diminished in the other districts.

With respect to the different kinds of line-caught fish taken in the closed waters of the Moray Firth, the following Table shows the quantities and average catches in each of the four years:—

FISH.	1894.		1895.		1896.		1897.	
	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.
Cod	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26
Ling	2,169	0·035	2,937	0·005	3,868	0·062	3,544	0·056
Torsk	25	0·002	24	—	94	—	25	—
Saithe	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18
Haddock	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004
Whiting	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052
Turbot	5	—	—	—	15	—	16	—
Halibut	254	0·004	403	0·007	691	0·011	707	0·011
Lemon Sole	—	—	—	—	19	—	14	—
'Flounder, Plaice, and Brill'*	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063
Conger	1,244	0·02	777	0·013	823	0·013	1,533	0·024
Skates	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063
Other kinds of White Fish	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105

* The fish included under this head comprise, for the most part, plaice and dabs.

This Table shows that the great bulk of the fish caught in each year within the whole area consisted of haddocks and cod. The preponderance of haddocks is most marked in the southern districts, where the greatest number of small-line boats are to be found. On the other hand, cod, ling, and saithe were relatively most marked in the catches landed in the northern districts, and especially at Wick.

The quantity of flat-fishes landed in each year was small. Of turbot and lemon sole only a few hundredweights were caught. The greater number are included under the heading 'flounder, plaice, and brill,' which comprise principally plaice and dabs. The total quantity of flat-fishes landed in each of the years was as follows :—5736 cwts., or 2·6 per cent. of the whole, in 1894 ; 6170 cwts., or 2·3 per cent., in 1895 ; 4127 cwts., or 1·6 per cent., in 1896 ; and 4715 cwts., or 1·9 per cent., in 1897. The slight increase indicated last year, as compared with the previous year, took place for the most part in the group 'flounders, plaice, and brill ;' there was also a slight increase in the quantity of halibut landed. It must not be forgotten that the increase in the quantities of halibut landed, as of cod, ling, saithe, conger, and skate, does not necessarily imply a greater abundance of these fishes on the fishing grounds. They are caught almost exclusively by the great-line boats, and, as we have seen, the number of shots made by these boats has very much increased ; while the averages given in the returns apply to all the 'shots,' both great-line and small-line, combined. In each of the four years with which the statistics deal an increased quantity of cod was landed from the closed waters, as compared with the year immediately preceding. This remark applies also to the average catch per 'shot' of the lines. In 1897, 79,731 cwts. were landed, as against 64,663 cwts. in 1896, 47,646 cwts. in 1895, and 32,571 cwts. in 1894. This increase is most marked in the Wick district, where great-line fishing in the closed waters has been greatly developed. The average per 'shot' steadily increased from 0·52 cwts. in 1894 to 1·26 cwts., or more than double, in 1897. The averages for each district in the various years are as follows :—

	1894.	1895.	1896.	1897.
Wick, - - -	0·99	1·83	3·22	4·16
Lybster, - - -	1·92	1·79	1·71	2·47
Helmsdale, - -	0·75	1·31	2·01	2·39
Cromarty, - - -	0·59	0·617	0·74	0·61
Findhorn, - - -	0·48	0·75	0·85	0·52
Buckie, - - -	0·55	1·0	1·3	1·68
Banff, - - -	0·13	0·2	0·22	0·41

These figures show the great increase in the average of cod in the northern districts and in the Buckie district ; in the other districts the change is not so striking.

The quantity of haddocks caught in the closed waters diminished considerably in 1897 as compared with the three preceding years. Thus the quantity landed was 153,529 cwts. in 1894 ; in 1895 it rose to 178,370 cwts., in 1896 it fell to 156,703 cwts., and last year to 126,031 cwts., or more than 50,000 cwts. under the catch in 1895. The average per 'shot' did not decline in the same ratio. Those for the various districts are shown in the following Table :—

	1894.	1895.	1896.	1897.
Wick, - - -	0·54	0·508	0·22	0·19
Lybster, - - -	1·63	1·29	0·69	1·028
Helmsdale, - -	2·16	2·11	2·2	1·59
Cromarty, - - -	2·18	1·96	1·51	1·54
Findhorn, - - -	3·31	3·73	3·32	1·92
Buckie, - - -	3·178	3·19	3·16	2·62
Banff, - - -	2·47	4·07	3·06	2·82

These figures show a diminished average in all the districts.

The next most abundant line-caught fish is the saithe or coal-fish, and the figures show that a slightly increased quantity was landed in 1897. In 1894 the total for the whole of the Moray Firth was 6120 cwts., with an average per 'shot' of 0·09 cwts.; last year the total was 11,761 cwts., with an average of 0·18 cwts. per 'shot.' The average catch has also increased, as a rule, in each year.

Both the total quantity and the average catch per 'shot' of whiting landed has decreased in each of the four years as compared with the year preceding. In 1894 the total for the whole area was 5845 cwts., with an average per 'shot' of 0·094 cwts.; in 1895 the total was 5114 cwts., with an average of 0·087 cwts.; in 1896 the total was 4836 cwts., and the average 0·08 cwts., while last year the total quantity fell to 3319 cwts., and the average catch to 0·052 cwts.

The quantity of conger landed in 1897 showed a considerable increase over that for the previous year, and the average also rose. There was also an increase in the total quantity of skate landed, but the average catch remained almost the same, the figures for the two years being 3683 cwts. and 3999 cwts., and the averages 0·061 cwts. and 0·063 cwts. respectively. Of other kinds of line-caught white fish not separately enumerated, the figures show a falling-off both in regard to quantity and to the average catch per 'shot.'

The figures given above show that the increase in the quantity of white fishes caught by line in the Moray Firth which occurred in 1895 has not been maintained in 1896 and 1897. The latter year shows a falling-off to the extent of 15,566 cwts. as compared with the previous year, and to the extent of 17,240 cwts. as compared with 1895. On the other hand, the total catch last year exceeded that of 1894 by 22,856 cwts. The variation has been caused for the most part by the fluctuations in the quantity of haddocks landed.

2. The Firth of Clyde.

During last year the twelve trawling stations in the Firth of Clyde were examined on three occasions, in April, May, and September; and a number of special hauls were made at other stations along selected lines, in order to determine the distribution of spawning fish and of immature fish at various parts of the area. The total number of hauls made was 106, many of them being made by small-meshed nets; and the work included an examination of various parts of Loch Fyne.

Comparison of the results obtained in the various years in which the stations were examined shows that, taking all stations together, and all kinds of fish, the average number caught per haul of the trawl has generally increased over the whole period, although fluctuations occurred in different years. In 1888 the general average was 109·7 per haul; in 1890 it was 99·5 per haul; in 1895 it was 113·4; in 1896 it was 120·7, and last year it was 112·5 fishes per haul of the net.

The averages for the two groups of flat-fishes and round-fishes show that the fluctuations have been for the most part in round-fishes; the average for flat-fishes has improved in each succeeding year. The averages are as follows:—

	1888.	1890.	1895.	1896.	1897.
Flat-Fishes, - -	61·2	61·1	64·7	75·5	84·8
Round-Fishes, - -	44·7	35·1	43·6	35·1	27·8

An examination of the statistics relating to the different kinds of fishes captured shows that the increase of flat-fishes took place for the most part among witch flounders and dabs, the average for plaice having only slightly increased. Plaice, however, are not so abundant in the Clyde as on the East Coast, the most common flat-fish being the comparatively worthless witch flounder; the general average for plaice in the Moray Firth, for example, is about twenty per 'shot,' while it is only slightly over two in the Clyde. The various tables showing the numbers and species of fishes taken in the course of the experiments, with the other data, will be found appended to this Report.

T. WEMYSS FULTON,
Scientific Superintendent.

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1897.

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
MORAY FIRTH—																	
Station I.																	
June 9, .	13	7	14	80	16	.	.	.	130	.	9	.	38	47	.	2	179
Nov. 8, .	62	.	6	20	.	.	.	.	88	4	.	.	5	9	1	6	104
	75	7	20	100	16	.	.	.	218	4	9	.	43	56	1	8	283
Station II.																	
June 9, .	2	1	13	23	23	.	.	.	62	10	1	.	8	19	.	2	83
Nov. 5, .	50	3	39	128	34	.	1	.	255	4	2	2	8	16	3	15	289
	52	4	52	151	57	.	1	.	317	14	3	2	16	35	3	17	372
Station III.																	
June 14, .	24	12	.	8	.	.	.	.	44	16	.	.	5	21	5	.	70
Nov. 6, .	51	.	.	1	.	.	.	.	52	3	.	.	1	4	.	.	56
	75	12	.	9	.	.	.	.	96	19	.	.	6	25	5	.	126
Station IV.																	
June 15, .	12	.	.	23	.	.	.	.	35	.	.	.	37	37	1	1	74
Nov. 11, .	79	.	.	7	.	.	.	.	86	.	.	.	.	.	.	.	86
	91	.	.	30	.	.	.	.	121	.	.	.	37	37	1	1	160
Station V.																	
June 15, .	11	2	.	17	.	.	1	.	31	.	.	.	11	11	.	.	42
Nov. 11, .	103	2	.	158	1	.	.	2	266	3	24	3	1	31	4	3	304
	114	4	.	175	1	.	1	2	297	3	24	3	12	42	4	3	346
Station VI.																	
June 15, .	14	5	.	45	.	.	.	.	64	.	.	.	22	22	.	1	87
Nov. 10, .	128	10	.	223	4	.	.	1	366	5	9	3	4	21	1	7	395
	142	15	.	268	4	.	.	1	430	5	9	3	26	43	1	8	482
Station VII.																	
June 10, .	.	5	1	91	41	.	.	.	138	.	6	2	3	11	.	2	151
Nov. 10, .	4	12	.	547	51	.	.	.	614	6	32	4	19	61	.	4	679
	4	17	1	638	92	.	.	.	752	6	38	6	22	72	.	6	830

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1897—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
MORAY FIRTH—*continued.*																	
Station VIII.																	
June 10, .	4	5	.	89	22	.	.	.	120	.	5	.	10	15	.	10	145
Nov. 9, .	5	16	2	323	66	.	.	.	412	2	30	3	33	68	.	6	486
	9	21	2	412	88	.	.	.	532	2	35	3	43	83	.	16	631
Station IX.																	
June 10, .	4	8	1	57	24	.	.	.	94	.	4	.	12	16	1	4	115
Nov. 9, .	.	17	1	293	79	.	.	.	390	14	38	3	35	90	2	3	485
	4	25	2	350	103	.	.	.	484	14	42	3	47	106	3	7	600
Station X.																	
June 10, .	4	8	2	70	37	.	.	.	121	1	64	.	6	71	1	7	200
Nov. 8, .	.	1	46	10	94	.	.	.	151	5	15	4	32	56	.	4	211
	4	9	48	80	131	.	.	.	272	6	79	4	38	127	1	11	411
Station XI.																	
June 11, .	2	9	.	20	.	.	.	.	31	1	2	.	17	20	.	3	54
Nov. 22, .	5	1	.	182	.	.	.	.	188	6	.	.	39	45	.	2	235
	7	10	.	202	.	.	.	.	219	7	2	.	56	65	.	5	289
Station XII.																	
June 11, .	9	8	.	38	1	.	.	.	56	.	7	.	10	17	2	1	76
Nov. 22, .	4	1	.	196	.	.	.	.	201	4	1	2	35	42	2	.	245
	13	9	.	234	1	.	.	.	257	4	8	2	45	59	4	1	321
Station XIII.																	
June 11, .	4	7	.	17	1	.	.	.	29	3	4	.	5	12	.	2	43
Nov. 20, .	7	16	.	65	.	.	.	1	89	14	9	.	12	35	2	3	129
	11	23	.	82	1	.	.	1	118	17	13	.	17	47	2	5	172
Station XIV.																	
June 11, .	4	12	.	55	28	.	.	.	99	.	18	1	17	36	.	2	137
Nov. 18, .	1	3	.	63	4	.	.	.	71	3	1	5	38	47	1	.	119
	5	15	.	118	32	.	.	.	170	3	19	6	55	83	1	2	256

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1897—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
MORAY FIRTH—*continued.*																	
Station XV.																	
June 11, .	1	9	.	116	32	.	.	.	158	.	90	2	57	149	1	1	309
Nov. 25, .	11	4	.	185	15	.	.	.	215	2	3	2	5	12	3	7	237
	12	13	.	301	47	.	.	.	373	2	93	4	62	161	4	8	546
Station XVI.																	
June 11, .	6	13	.	27	11	.	.	.	57	.	.	.	3	3	5	5	70
FIRTH OF CLYDE.																	
Station I.																	
April 5, .	4	4	.	9	12	3	.	.	32	1	7	.	12	20	6	5	63
May 25, .	2	10	4	11	12	.	.	.	39	3	7	1	14	25	9	14	87
Sept. 14, .	4	31	.	19	.	.	.	.	54	.	1	.	2	3	20	11	88
	10	45	4	39	24	3	.	.	125	4	15	1	28	48	35	30	238
Station II.																	
April 3, .	3	2	.	16	2	1	.	.	24	.	.	.	1	1	1	.	26
May 19, .	4	8	2	24	15	.	.	.	53	1	3	.	5	9	2	2	66
Sept. 14, .	14	18	.	65	6	.	.	.	103	.	.	1	14	15	.	16	134
	21	28	2	105	23	1	.	.	180	1	3	1	20	25	3	18	226
Station III.																	
April 2, .	.	9	48	.	17	.	.	.	74	1	.	.	2	3	4	16	97
May 19, .	.	3	91	4	34	.	.	.	132	2	.	1	.	3	1	10	146
Sept. 13, .	4	4	48	1	12	.	.	.	69	1	.	.	4	5	.	5	79
	4	16	187	5	63	.	.	.	275	4	.	1	6	11	5	31	322
Station IV.																	
April 2, .	.	8	2	.	2	.	.	.	12	.	2	.	.	2	1	4	19
May 19, .	.	3	28	.	7	.	.	.	38	.	.	.	2	2	.	9	49
Sept. 13, .	.	.	1	2	2	.	.	.	5	1	6	.	17	24	1	9	39
	.	11	31	2	11	.	.	.	55	1	8	.	19	28	2	22	107
Station V.																	
April 25, .	4	13	7	2	5	.	.	.	31	.	2	.	2	4	2	6	43
May 20, .	4	8	1	8	.	.	.	.	21	.	2	.	3	5	.	3	29
Sept. 24, .	.	4	.	1	.	.	.	.	5	.	1	.	3	4	6	11	26
	8	25	8	11	5	.	.	.	57	.	5	.	8	13	8	20	98

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1897—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
FIRTH OF CLYDE—*continued.*																	
Station VI.																	
April 5, .	23	14	.	23	2	.	.	.	62	1	31	11	187	230	10	22	324
May 25, .	.	19	.	37	1	.	.	.	57	2	3	1	15	21	23	27	128
Sept. 15, .	1	.	.	51	.	.	.	.	52	.	13	.	13	26	25	7	110
	24	33	.	111	3	.	.	.	171	3	47	12	215	277	58	56	562
Station VII.																	
April 27, .	1	5	167	17	1	.	.	.	191	.	6	4	7	17	5	6	219
May 17, .	.	2	18	19	1	.	.	4	44	.	11	6	38	55	7	14	120
Sept. 29, .	.	2	.	42	.	.	.	.	44	.	3	4	23	30	9	64	147
	1	9	185	78	2	.	.	4	279	.	20	14	68	102	21	84	486
Station VIII.																	
April 27, .	.	1	108	10	4	.	.	.	123	.	3	9	44	56	2	36	217
May 17, .	1	.	208	2	4	.	.	1	216	.	3	12	45	0	1	25	302
Sept. 29, .	.	.	30	.	.	.	.	.	30	.	1	9	30	40	3	23	96
	1	1	346	12	8	.	.	1	369	.	7	30	119	156	6	84	615
Station IX.																	
April 22, .	1	1	168	1	1	.	.	.	172	.	.	2	47	49	8	49	278
May 17, .	.	.	127	2	5	.	.	1	135	.	1	5	55	61	7	30	233
Sept. 28, .	.	.	24	.	.	.	.	.	24	.	.	10	17	27	9	18	78
	1	1	319	3	6	.	.	1	331	.	1	17	119	137	24	97	589
Station X.																	
April 28, .	.	3	97	8	20	.	.	1	129	.	7	8	67	82	5	29	245
May 22, .	1	4	89	28	68	.	1	.	191	.	8	1	32	41	5	34	271
Sept. 15, .	.	.	1	4	1	.	.	.	6	.	3	.	4	7	12	3	28
	1	7	187	40	89	.	1	1	326	.	18	9	103	130	22	66	444
Station XI.																	
April 21, .	5	6	33	32	69	1	.	.	146	.	2	4	16	22	6	34	208
May 20, .	2	9	39	8	36	.	.	.	94	1	.	.	12	13	3	7	117
Sept. 27, .	6	1	52	8	25	.	.	.	92	1	.	5	22	28	6	61	187
	13	16	124	48	130	1	.	.	332	2	2	9	50	63	15	102	512
Station XII.																	
April 21, .	.	.	76	1	69	.	1	.	147	.	1	1	2	4	2	23	176
May 20, .	.	.	43	1	79	.	.	.	123	.	.	2	2	4	1	21	149
Sept. 24, .	7	.	184	.	91	.	.	.	282	.	.	.	2	2	1	9	294
	7	.	303	2	239	.	1	.	552	.	1	3	6	10	4	53	619

TABLE B.—ANALYSIS OF THE 'GARLAND'S' STATISTICS RELATING TO THE RELATIVE ABUNDANCE OF FISH.

Station.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
								I. Moray Firth.									
I.	37·5	3·5	10·0	50·0	8·0	–	–	–	109·0	2·0	4·5	–	21·5	28·0	0·5	4·0	141·5
II.	26·0	2·0	26·0	75·5	28·5	–	0·5	–	158·5	7·0	1·5	1·0	8·0	17·5	1·5	8·5	186·0
III.	37·5	6·0	–	4·5	–	–	–	–	48·0	9·5	–	–	3·0	12·5	2·5	–	63·0
IV.	45·5	–	–	15·0	–	–	–	–	60·5	–	–	–	18·5	18·5	0·5	0·5	80·0
V.	57·0	2·0	–	87·5	0·5	–	0·5	1·0	148·5	1·5	12·0	1·5	6·0	21·0	2·0	1·5	173·0
VI.	71·0	7·5	–	134·0	2·0	–	–	0·5	215·0	2·5	4·5	1·5	13·0	21·5	0·5	4·0	241·0
VII.	2·0	8·5	0·5	319·0	46·0	–	–	–	376·0	3·0	19·0	3·0	11·0	36·0	–	3·0	415·0
VIII.	4·5	10·5	1·0	206·0	44·0	–	–	–	266·0	1·0	17·5	1·5	21·5	41·5	–	8·0	315·5
IX.	2·0	12·5	1·0	175·0	51·5	–	–	–	242·0	7·0	21·0	1·5	23·5	53·0	1·5	3·5	300·0
X.	2·0	4·5	24·0	40·0	65·5	–	–	–	136·0	3·0	39·5	2·0	19·0	63·5	0·5	8·5	205·5
XI.	3·5	5·0	–	101·0	–	–	–	–	109·5	3·5	1·0	–	28·0	32·5	–	2·5	144·5
XII.	6·5	4·5	–	117·0	0·5	–	–	–	128·5	2·0	4·0	2·0	22·5	29·5	2·0	0·5	160·5
XIII.	5·5	11·5	–	41·0	0·5	–	–	0·5	59·0	8·5	6·5	–	8·7	23·5	1·0	2·5	86·0
XIV.	2·5	7·5	–	59·0	16·0	–	–	–	85·0	1·5	9·5	3·0	27·5	41·5	0·5	1·0	128·0
XV.	6·0	6·5	–	150·5	23·5	–	–	–	186·5	1·0	46·5	2·0	31·0	80·5	2·0	4·0	273·0
XVI.	6·0	13·0	–	27·0	11·0	–	–	–	57·0	–	–	–	3·0	3·0	5·0	5·0	70·0
								II. Firth of Clyde.									
I.	3·5	15·0	1·3	13·0	8·0	1·0	–	–	41·7	1·3	5·0	0·3	9·3	16·0	11·7	10·0	79·3
II.	7·0	9·3	0·7	35·0	7·8	0·3	–	–	60·0	0·3	1·0	0·3	6·7	8·3	1·0	6·0	75·3
III.	1·3	5·3	62·3	1·7	21·0	–	–	–	91·7	1·3	–	0·3	2·0	3·7	1·7	10·3	107·3
IV.	–	3·7	10·3	0·7	3·7	–	–	–	18·3	0·3	2·7	–	6·3	9·3	0·7	7·3	35·7
V.	2·7	8·3	2·7	3·7	1·7	–	–	–	19·0	–	1·7	–	2·7	4·3	2·7	6·7	32·7
VI.	8·0	11·0	–	37·0	1·0	–	–	–	57·0	1·0	15·7	4·0	71·7	92·3	19·3	18·7	187·3
VII.	0·3	3·0	61·7	26·0	0·7	–	–	1·3	93·0	–	6·7	4·7	22·7	34·0	7·0	28·0	162·0
VIII.	0·3	0·3	115·3	4·0	2·7	–	–	0·3	123·0	–	2·3	10·0	39·7	52·0	2·0	28·0	205·0
IX.	0·3	0·3	106·3	1·0	2·0	–	–	0·3	110·3	–	0·3	5·7	39·7	45·7	8·0	32·3	196·3
X.	0·3	2·3	62·3	13·3	29·7	–	0·3	0·3	108·7	–	6·0	3·0	34·3	43·0	7·3	22·0	148·0
XI.	4·3	5·3	41·3	16·0	43·3	0·3	–	–	110·7	0·7	0·7	3·0	16·7	21·0	5·0	34·0	170·7
XII.	2·3	–	101·0	0·7	79·7	–	0·3	–	184·0	–	0·3	1·0	2·0	3·3	1·3	17·7	206·3

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—I. Moray Firth.

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station I. 1897. June 9. 1 hour 50 min.	Plaice,	.	2	1	1	.	.	2	1	1	.	2	1	1	.	1	.	.	.	.	.	13
	Lemon soles,	.	.	.	2	1	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	7
	Common dabs,	.	10	23	24	15	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	80*
	Witch soles,	.	.	.	.	.	.	.	1	2	.	4	3	2	2	.	.	.	.	.	.	14
	Long rough dabs,	.	.	1	8	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Haddocks,	.	.	.	.	1	2	.	3	2	1	.	.	.	.	.	.	.	.	.	.	9
	Gurnards,	.	2	18	10	.	3	2	1	2	.	.	.	.	.	.	.	.	.	.	.	38
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	2
																						179
Nov. 8. 2 hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	2
	Gurnards,	.	.	.	.	1	1	1	.	1	.	.	.	.	1	.	.	.	.	.	.	5
	Cod,	.	.	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	4
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	2	7	7	6	12	4	.	5	6	2	6	.	.	2	3	.	.	62
	Common dabs,	1	.	6	6	4	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	20
	Witch soles,	.	3	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Dragonets,	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																						104
Station II. 1896. June 9. 2 hours.	Plaice,	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Lemon soles,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	1	10	8	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23†
	Witch soles,	.	.	.	.	.	.	1	.	1	3	3	3	1	.	1	.	.	.	.	.	13
	Long rough dabs,	.	.	1	6	5	8	3	.	.	.	.	.	.	.	.	.	.	.	.	.	23
	Haddock,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	1	1	.	10
	Gurnards,	.	.	3	.	.	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	8
	Auglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2‡
																						83
Nov. 5. 2 hours.	Thornback skate,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Anglers,	.	.	.	.	.	.	.	.	4	3	.	.	.	.	.	.	.	.	.	.	9§
	Gurnards,	.	1	1	1	1	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	8
	Cod,	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Haddocks,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	2
	Ling,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Solenette,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	.	.	.	3	7	13	11	5	.	.	.	.	.	.	39
	Lemon soles,	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	5	27	57	19	11	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	128
	Long rough dabs,	.	1	3	10	16	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34
	Plaice,	.	.	.	5	5	9	13	11	4	1	1	.	.	1	.	.	.	.	.	.	50
	Butter-fish,	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3‖
	Four-bearded rockling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
																						289
Station III. 1896. June 14. 1 hour 10 min.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	2	5
	Plaice,	.	.	.	.	2	6	3	.	3	.	4	.	2	.	3	.	1	.	.	.	24
	Lemon soles,	.	.	.	4	2	4	.	1	.	.	1	.	.	.	.	.	.	.	.	.	12
	Common dabs,	.	.	4	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8
	Cod,	.	.	.	.	1	4	2	3	.	.	1	.	2	.	1	.	.	.	.	.	**16
	Gurnards,	.	.	.	.	.	3	.	.	.	.	.	2	.	.	.	.	.	.	.	.	5
																						70

* One 3½ inches.

† One 26, two 30, one 37, one 39 inches.

‖ One 8½ inches.

¶ 2½ inches.

‡ One 46 inches.

** One 28, one 29 inches.

§ One 28, one 30 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT—I. MORAY FIRTH—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Nov. 6. 1 hour.	Cod,	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Gurnards,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	1	.	.	.	1	5	8	10	8	11	6	.	1	.	.	.	.	.	51
	Common dabs,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						56
Station IV. 1897. June 15. 2 hours 5 min.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Plaice,	.	3	.	2	2	.	.	.	.	1	1	.	1	.	.	1	.	.	1	.	12
	Common dabs,	.	3	13	4	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23
	Gurnards,	.	2	10	3	7	10	4	.	1	.	.	.	.	.	.	.	.	.	.	.	37
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																						74
Nov. 11. 2 hours 10 min.	Plaice,	.	6	24	14	4	3	5	8	10	2	1	1	.	.	.	.	.	.	.	.	79*
	Common dabs,	.	1	2	.	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	7
																						86
Station V. 1897. June 15. 1 hour 45 min.	Plaice,	.	3	.	1	2	1	1	.	.	.	.	.	.	1	.	2	.	.	.	.	11
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
	Common dabs,	.	2	6	6	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Gurnards,	.	1	5	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
																						42
Nov. 11. 1 hour 40 min.	Thornback skate,	.	.	.	.	.	.	2	.	.	1	.	.	.	.	1	.	.	.	.	.	4
	Anglers,	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Dragonets,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	3
	Haddocks,	.	.	.	.	.	.	.	.	.	2	5	3	.	8	2	4	.	.	.	.	24
	Whitings,	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	3
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2
	Plaice,	.	.	10	17	16	9	7	8	9	9	9	.	.	.	.	5	.	2	2	.	103
	Lemon soles,	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	1	35	69	30	17	5	.	.	.	1	.	.	.	.	.	.	.	.	.	.	158
	Long rough dabs,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
																						304
Station VI. 1897. June 15. 1 hour 45 min.	Plaice,	1	2	.	1	1	.	1	.	1	.	1	.	2	.	1	1	.	.	2	.	14
	Lemon soles,	.	.	.	1	.	.	1	.	.	.	1	.	1	1	.	.	.	.	.	.	5
	Common dabs,	1	12	16	14	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	45
	Gurnards,	.	1	15	5	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	22
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																						87
Nov. 10. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	3
	Dragonets,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	.	1	.	1	.	2	.	.	1	.	.	.	.	.	.	.	.	5
	Haddocks,	.	.	.	.	.	.	.	2	2	1	4	.	.	.	.	.	.	.	.	.	9
	Whitings,	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Plaice,	.	.	22	29	.	7	.	11	27	.	2	4	.	2	13	3	5	.	1	1	128†
	Lemon soles,	.	.	.	1	3	3	1	.	.	1	.	1	.	.	.	.	.	.	.	.	10
	Common dabs,	2	48	100	50	14	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	223
	Long rough dabs,	.	3	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3‡
																						395

* One 28 inches. † One 36 inches. ‡ Two at 2½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station VII.																						
1897. June 10. 2 hours.	Lemon soles,	.	.	1	2	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	5
	Common dabs,	.	12	33	42	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	91
	Witch soles,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	4	26	7	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	41
	Haddocks,	.	.	.	.	1	.	1	1	3	.	.	.	.	.	.	.	.	.	.	.	6
	Whitings,	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Anglers,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pogge,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						151
Nov. 10. 1 hour 47 min.	Cod,	.	.	.	.	.	1	.	3	.	.	1	.	.	.	.	.	.	.	.	.	6*
	Haddocks,	.	.	.	1	2	2	11	.	7	5	.	2	1	1	.	.	.	.	.	.	32
	Whitings,	.	2	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Brassie,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3†
	Gurnards,	.	1	5	1	5	3	.	.	.	1	2	.	1	.	.	.	.	.	.	.	19
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	4
	Common dabs,	8	59	286	116	74	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	547
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	1	7	2	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	12
	Long rough dabs,	.	4	12	12	16	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	51
																						679
Station VIII.																						
1897. June 10. 1 hour 54 min.	Plaice,	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	4
	Lemon soles,	.	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Common dabs,	.	17	32	30	9	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	89
	Long rough dabs,	1	.	3	13	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
	Haddocks,	.	.	.	.	.	.	1	1	3	.	.	.	.	.	.	.	.	.	.	.	5
	Gurnards,	1	.	4	2	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	1	2	.	1	7‡
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2
																						145
Nov. 9. 2 hours 5 min.	Cod,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	3
	Haddocks,	.	.	2	.	.	1	3	10	.	9	3	1	1	.	.	.	.	.	.	.	30
	Dragonets,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	2	5
	Gurnards,	.	5	14	1	2	6	.	.	3	2	.	.	.	.	.	.	.	.	.	.	33
	Plaice,	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.	5
	Lemon soles,	.	.	4	.	2	2	1	1	1	.	2	1	1	1	.	.	.	.	.	.	16
	Witch soles,	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	2
	Common dabs,	4	99	138	78	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	323
	Long rough dabs,	.	1	10	14	20	18	3	.	.	.	.	.	.	.	.	.	.	.	.	.	66
																						486
Station IX.																						
1897. June 10. 1 hour 52 min.	Starry ray,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	5	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	8
	Common dabs,	.	8	20	20	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	57
	Witch soles,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	4	10	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
	Haddocks,	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	4
	Gurnards,	.	1	3	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2‖
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	¶2
																						115

* One 36 inches. † One 3½ inches. ‡ One 28 inches. § 28 inches. ‖ One 31 inches. ¶ One 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Nov. 9. 2 hours.	Starry rays,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Anglers,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3
	Gurnards,	.	.	6	8	7	6	3	3	1	.	1	.	.	.	.	.	.	.	.	.	35
	Whitings,	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	3
	Haddocks,	.	.	.	.	.	.	1	7	15	12	2	.	.	1	.	.	.	.	.	.	38
	Cod,	.	.	.	.	1	4	8	.	1	.	.	.	.	.	.	.	.	.	.	.	14
	Lemon soles,	.	.	.	2	4	5	3	.	.	3	.	.	.	.	.	.	.	.	.	.	17
	Common dabs,	2	63	119	88	20	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	293
	Long rough dabs,	.	1	35	29	13	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	79
	Witch soles,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Station X.																						485
1897. June 10. 1 hour 52 min.	Thornback skate,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	1	3	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	8
	Common dabs,	.	4	23	12	18	4	9	.	.	.	.	.	.	.	.	.	.	.	.	.	70
	Witch soles,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	2
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	1	.	4
	Long rough dabs,	.	.	15	20	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	37
	Haddocks,	.	.	.	3	5	8	.	19	24	4	.	1	.	.	.	.	.	.	.	.	64
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Gurnards,	.	.	.	1	1	3	.	.	1	.	.	.	.	.	.	.	.	.	.	.	6
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1†
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
																						200
Nov. 8. 1 hour 40 min.	Cod,	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5‖
	Haddocks,	.	.	.	.	.	.	.	2	4	8	1	.	.	.	.	.	.	.	.	.	15
	Whitings,	.	.	.	.	.	.	2	1	.	.	.	1	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	1	2	.	.	.	.	1	.	.	.	.	.	.	.	.	4
	Gurnards,	.	.	1	3	6	12	8	1	1	.	.	.	.	.	.	.	.	.	.	.	32
	Lemon soles,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	1	4	4	.	4	3	5	15	.	4	6	.	.	.	.	.	.	46
	Common dabs,	.	5	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Long rough dabs,	.	3	32	49	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	94
Station XI.																						211
1897. June 11. 1 hour 50 min.	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	2
	Lemon soles.	.	.	.	4	.	.	2	.	1	.	.	1	1	.	.	.	.	.	.	.	9
	Common dabs,	.	1	6	10	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
	Haddocks,	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	2
	Cod,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	1	9	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶3
																						54
Nov. 22. 2 hours.	Cod,	.	.	.	.	.	.	.	.	1	.	1	.	.	1	1	1	.	.	.	1	6
	Gurnards,	.	.	3	6	7	6	6	7	1	3	.	.	.	.	.	.	.	.	.	.	39
	Dragonets,	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	1	1	.	.	5
	Common dabs.	11	78	47	25	16	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	182
	Lemon soles,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Station XII.																						235
1897. June 11. 1 hour 50 min.	Starry ray,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Sandy ray,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	2	.	.	2	.	.	3	2	.	.	.	.	9
	Lemon soles,	.	.	.	4	1	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	8
	Common dabs,	.	7	17	5	3	4	.	.	2	.	.	.	.	.	.	.	.	.	.	.	38
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	1	1	1	1	1	2	.	.	.	.	.	.	.	.	7
	Gurnards,	.	.	3	3	3	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	10
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
																						76

* 28 inches. † 34 inches. ‡ 37 inches. § 28 inches. ‖ One over 40 inches.
¶ Two at 30, one at 39 inches. ** 41 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT—I. MORAY FIRTH—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Nov. 22. 2 hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	Cod, . . .	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	4
	Haddocks, . .	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Whitings, . .	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Gurnards, . .	.	.	2	6	6	17	3	1	.	.	.	.	.	.	.	.	.	.	.	.	35
	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	4
	Lemon soles, .	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Common dabs, .	24	81	53	23	9	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	196
																						245
Station. XIII. 1897. June 11. 1 hour 25 min.	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	1	.	4
	Lemon soles, .	.	.	.	1	2	.	1	.	1	.	1	.	1	.	.	.	.	.	.	.	7
	Common dabs, .	.	6	6	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks, .	.	.	.	.	.	.	.	.	.	1	.	2	1	.	.	.	.	.	.	.	4
	Cod, . . .	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	3
	Gurnards, .	.	.	2	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	5
	Anglers, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
																						43
Nov. 28. 2 hours.	Fuller's ray, .	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Cod, . . .	.	.	.	.	.	.	1	3	5	1	2	1	1	.	.	.	.	.	.	.	14
	Haddocks, . .	.	.	1	.	.	.	.	.	1	.	2	2	1	.	1	.	.	.	1	.	9
	Gadus minutus, .	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards, . .	.	.	.	3	2	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	12
	Anglers, . .	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1†
	Brill, . . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	.	4	.	2	.	.	1	.	.	7
	Lemon soles, .	.	.	.	4	3	.	2	.	1	3	2	.	.	1	.	.	.	.	.	.	16
	Common dabs, .	2	8	20	17	12	.	3	2	.	1	.	.	.	.	.	.	.	.	.	.	65
																						129
Station XIV. 1897. June 11. 1 hour 55 min.	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	.	.	.	.	.	4
	Lemon soles, .	.	.	1	1	2	3	.	1	1	1	1	.	.	1	.	.	.	.	.	.	12
	Common dabs, .	3	20	21	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	55
	Long rough dabs,	.	.	4	5	12	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	28
	Haddocks, . .	.	.	.	.	.	.	.	5	8	4	1	.	.	.	.	.	.	.	.	.	18
	Whitings, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Gurnards, . .	.	.	.	1	1	6	6	.	3	.	.	.	.	.	.	.	.	.	.	.	17
	Pogge, . .	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						137
Nov. 18. 2 hours.	Grey ray, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Cod, . . .	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	3
	Haddocks, . .	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings, . .	.	.	.	.	.	.	4	.	.	.	1	.	.	.	.	.	.	.	.	.	5
	Gurnards, . .	.	.	9	9	13	4	1	1	.	.	1	.	.	.	.	.	.	.	.	.	38
	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Lemon soles, .	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs, .	1	26	24	7	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	63
																						119
Station XV. 1897. June 11. 1 hour 55 min.	Starry ray, . .	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Plaice, . .	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Lemon soles, .	.	.	.	3	2	1	.	2	.	.	1	.	.	.	.	.	.	.	.	.	9
	Common dabs, .	.	16	47	33	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	116
	Long rough dabs,	.	.	4	8	19	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32
	Haddocks, . .	.	.	.	.	4	6	10	28	31	10	.	1	.	.	.	.	.	.	.	.	90
	Whitings, . .	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	2
	Gurnards, . .	.	.	8	13	11	11	14	.	.	.	.	.	.	.	.	.	.	.	.	.	57
	Catfish, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
																						309

* 25 inches. † 33 inches. ‡ 30 inches. § 38 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Nov. 25. 2 hours.	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Thornback skate,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2
	Cod,	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Haddocks,	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	3
	Whitings,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	1	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Anglers,	.	3	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	2	6	.	3	.	.	.	.	.	11
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Lemon soles,	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	.	.	7	4	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Common dabs,	13	95	49	23	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	185
																						237
Station XVI. 1897. June 11. 1 hour 45 min.	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Starry rays,	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	3
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3	.	.	.	.	.	6
	Lemon soles,	.	.	.	4	.	1	.	1	1	.	1	3	2	.	.	.	.	.	.	.	13
	Common dabs,	.	4	9	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27
	Long rough dabs,	.	.	1	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Gurnards,	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Anglers,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	4
	Dragonets,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						70

II. Firth of Clyde.

Station, Date, and Time Trawl down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station I. 1897. Apr. 5. 1½ hours.	Thornback skate,	.	.	.	.	1	.	1	2	1	.	.	.	.	1	.	.	.	.	.	.	6
	Plaice,	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	.	3	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	1	2	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Flounders,	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	.	2	8	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Haddocks,	.	.	.	.	.	3	2	1	1	.	.	.	.	.	.	.	.	.	.	.	7
	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Com. Gurnards,	.	2	.	6	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Red Gurnards,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dory,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						63
May 25. 1½ hours.	Thornback skate,	.	2	.	.	.	.	2	.	1	.	.	2	.	.	.	1	1	.	.	.	9
	Plaice,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon soles,	.	.	1	3	1	2	2	.	1	.	.	.	.	.	.	.	.	.	.	.	10
	Common dabs,	.	.	2	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Witch soles,	.	.	.	.	.	1	.	.	1	.	1	.	.	1	.	.	.	.	.	.	4
	Long rough dabs,	.	.	8	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Haddocks,	.	.	.	.	.	2	2	2	.	.	.	1	.	.	.	.	.	.	.	.	7
	Cod,	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	3
	Whitings,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	3	2	6	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	14
	Red Gurnards,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	.	.	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3†
	Dory,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lesser spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2‡
																						87

* 48 inches. † 26, 28, and 30 inches. ‡ 27 and 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Sept. 14. 1¼ hours.	Spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Hake, .	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	.	3
	Haddocks, .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards, .	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gadus minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2†
	Plaice,	.	.	.	.	.	.	.	1	2	.	1	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	3	6	7	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Lemon soles,	.	.	.	1	7	4	1	2	10	4	2	.	.	.	.	.	.	.	.	.	31
	Black soles,	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	.	.	3
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2‡
	Cuckoo skate,	.	.	.	.	1	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	4
	Skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	1	1	5	1	2	4	.	1	.	.	.	.	.	.	.	.	.	.	15
																						88
Station II. 1897. Apr. 3. 1⅛ hours.	Thornback skate,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.	.	3
	Lemon soles,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	4	3	3	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Flounders, .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards, .	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						26
May 19. 1¾ hours	Thornback skate,	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	1	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	1	3	.	2	2	.	.	.	.	.	.	.	.	.	1	.	.	8
	Common dabs,	.	4	14	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
	Witch soles,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	2	5	4	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Black soles,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks, .	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	3
	Cod, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Gurnards, .	1	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Dragonets, .	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						66
Sept. 14. 2¼ hours.	Plaice,	.	.	.	.	.	.	1	1	4	.	1	1	2	.	1	1	1	.	1	.	14
	Lemon soles,	.	.	2	1	4	5	3	2	.	.	.	1	.	.	.	.	.	.	.	.	18
	Common dabs,	.	11	12	30	7	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	65
	Long rough dabs,	.	.	1	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Black soles,	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	2
	Whitings, .	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Hake, .	.	.	.	.	.	.	.	2	2	.	3	1	.	.	.	.	.	.	.	.	9§
	Gurnards, .	1	.	4	4	.	1	.	2	.	.	1	.	1	.	.	.	.	.	.	.	14
	Gadus minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4‖
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
																						134
Station III. 1897. Apr. 2. 1⅛ hours.	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	**3
	Lemon soles,	.	.	.	1	2	.	2	1	2	.	.	.	.	1	.	.	.	.	.	.	9
	Witch soles,	.	.	.	.	7	.	.	4	5	9	15	8	.	.	.	.	.	.	.	.	48
	Long rough dabs,	.	1	10	5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Cod, .	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Gurnards, .	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	4	5	.	2	.	.	.	.	.	.	.	1	.	12
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	‡‡2
	Zeugopterus punctatus,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						97

* 28 inches. † Under 2 inches. ‡ 26 and 28 inches. § One 26 inches. ‖ Three under 2 inches, one under 3 inches.
¶ 28 inches. ** Under 4 inches broad. †† 42 inches. ‡‡ One at 27 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT—II. FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 19. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Lemon soles,	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Witch soles,	.	.	.	1	2	6	1	11	12	24	19	3	12	.	.	.	.	.	.	.	91
	Long rough dabs,	4	.	5	12	9	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34
	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2*
	Whitings,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Hake,	.	.	.	.	.	.	1	2	2	.	1	.	.	.	.	1	.	.	.	1	8
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
																						146
Sept. 13. 55 minutes	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	1	4
	Lemon soles,	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	.	2	2	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Common dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	6	4	10	23	4	1	.	.	.	.	.	.	.	.	48
	Hake,	.	.	.	.	.	.	1	.	2	.	.	1	.	.	.	.	.	.	.	.	5†
	Gurnards,	.	.	.	.	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
																						79
Station IV. 1897. April 2. ¼ hour.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Lemon soles,	.	.	.	2	.	.	2	3	1	.	.	.	.	.	.	.	.	.	.	.	8
	Witch soles,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddocks,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	3
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
																						19
May 19. ¼ hour.	Lemon soles	.	.	.	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	3
	Witch soles,	.	.	.	.	2	5	3	5	6	1	1	4	1	.	.	.	.	.	.	.	28
	Long rough dabs,	.	.	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Gurnards,	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	3
	Hake,	.	.	.	.	.	.	.	1	1	.	2	2	.	.	.	.	.	.	.	.	6
																						49
Sept. 13. 40 minutes	Long rough dabs,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	1	1	.	.	.	7
	Gurnards,	.	.	3	4	.	4	.	5	.	1	.	.	.	.	.	.	.	.	.	.	17
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	1	3	2	.	.	.	.	.	.	.	.	.	.	.	6
	Brassie,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2§
	Skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						39
Station V. 1897. April 25. 1$\tfrac{7}{12}$ hours.	Thornback skate,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Shagreen ray (*Raia fullonica*),	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	5	.	.	3	4	.	1	.	.	.	.	.	.	.	.	.	.	13
	Common dabs,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	1	.	1	2	.	2	1	.	.	.	.	.	.	.	.	7
	Long rough dabs,	.	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Haddocks,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Com. Gurnards,	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	4
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																						43

* One at 26 inches. † One at 28 inches. ‡ 56 inches. § One under 4 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 20. 1½ hour.	Plaice,	.	.	.	.	.	1	.	2	.	1	.	.	.	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	2	1	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	8
	Witch soles,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	2	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Haddocks,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Ctenolabrus rupestris,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1*
																						29
Sept. 24. 10.40 a.m. to 11.40 a.m.	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2†
	Thornback skate.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	4
	Cuckoo rays,	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	1	3	1	1	.	1	.	.	.	.	.	7
	Saithe,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon soles,	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Liparis montagui,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Haddocks,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
																						26
Station VI. 1897. April 5. 2 hours.	Thornback skate.	.	.	.	.	.	.	.	.	1	.	2	2	.	.	4	.	.	.	.	1	10
	Plaice,	.	.	.	.	.	.	2	.	.	4	14	.	2	.	.	.	.	.	.	1	23
	Lemon soles,	.	.	.	1	1	.	4	3	1	2	.	1	1	.	.	.	.	.	.	.	14
	Common dabs,	.	3	13	4	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23
	Long rough dabs,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddocks,	.	.	.	.	.	.	12	7	.	5	1	4	.	.	.	.	.	.	1	1	31
	Cod,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	2	.	2	3	.	.	1	.	.	3	.	.	.	.	.	11
	Saithe,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lythe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	6§
	Com. gurnards,	.	.	2	17	70	31	24	15	21	5	2	.	.	.	.	.	.	.	.	.	187
	Red gurnards,	.	.	1	.	.	.	.	1	1	.	.	2	.	.	.	.	.	.	.	.	5
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‖
	Brassies,	.	.	.	.	2	.	2	1	.	2	.	.	.	.	.	.	.	.	.	.	¶9
																						324
May 25. 1½ hours.	Grey skate,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	2	2	.	.	.	6	5	.	.	.	.	.	1	**17
	Sandy ray,	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	††4
	Raia maculata,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	1	5	4	6	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	19
	Common dabs,	2	4	18	10	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
	Long rough dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Black soles,	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
	Haddocks,	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cod,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	3	1	3	2	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	15
	Red gurnards,	.	.	.	1	.	.	1	1	.	.	1	2	1	.	.	.	.	.	.	.	7
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	‡‡4
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	.	§§4
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖1
	Dragonet,	.	1	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Lesser spotted dog-fish.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	¶¶3
																						128

* 2¼ inches. † One 30 inches. ‡ 1½ inches. § One 28, one 29, two 32, one 35 inches. ‖ 43 inches. ¶ Two under 3 inches. ** One 29 inches. †† Two under 4 inches. ‡‡ One 29 inches. §§ One 33 inches, ‖‖ One 36 inches, ¶¶ One 28, one 29 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
1897. Sept. 15. 8.35 a.m. to 10.35 a.m.	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2†
	Thornback skate,	4	.	.	.	.	3	.	3	1	1	3	2	.	.	.	2	.	.	.	.	20‡
	Cuckoo ray,	.	.	.	.	4	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	5
	Spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	2
	Haddocks,	.	.	.	.	.	.	1	4	7	.	1	.	.	.	.	.	.	.	.	.	13
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	2
	Gurnards	.	.	3	5	3	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	13
	Black soles,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	1	13	31	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	51
																						110
Station VII. 1897. *Apl. 26-27 1¾ hours.	Thornback skate,	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6§
	Lemon soles,	.	.	1	2	.	3	.	.	.	.	1	1	.	.	.	.	.	.	.	.	8
	Common dabs,	1	4	15	12	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34
	Witch soles,	.	.	.	.	1	14	10	9	8	9	.	1	3	.	.	.	.	.	.	.	55
	Long rough dabs,	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Black soles,	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	.	.	3
	Haddocks,	.	.	.	1	9	19	21	2	.	.	.	.	.	.	.	.	.	1	.	.	53
	Whitings,	.	.	.	3	12	16	11	10	.	1	.	.	.	.	.	.	.	.	.	.	53
	Gurnards,	.	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	2
	Hake,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassies,	.	.	1	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
																						231
April 27. 1¾ hours.	Thornback skate,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5‖
	Plaice,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	.	1	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	5
	Common dabs,	.	6	5	3	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Witch soles,	.	.	.	.	.	5	6	28	52	34	41	11	.	.	.	.	.	.	.	.	167
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Black soles,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	1	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	6
	Whitings,	.	.	.	.	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	4
	Gurnards,	.	.	1	1	.	3	.	1	1	.	.	.	.	.	.	.	.	.	.	.	7
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3
	Hake,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
																						219
May 17. 1¾ hours.	Thornback skate,	.	1	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	¶7
	Lemon soles,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	1	5	10	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Witch soles,	.	.	.	.	1	1	9	2	1	2	1	.	1	.	.	.	.	.	.	.	18
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Black soles,	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	4
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	1	.	4
	Haddocks,	.	.	.	.	.	4	5	2	.	.	.	.	.	.	.	.	.	.	.	.	11
	Whitings,	.	.	.	.	.	2	2	1	.	1	.	.	.	.	.	.	.	.	.	.	6
	Gurnards,	1	6	3	13	7	2	4	.	2	.	.	.	.	.	.	.	.	.	.	.	38
	Red gurnards,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	**5
	Hake,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						120

* Hauls made at night. † 28 inches. ‡ One 51 inches. § Three under 4 inches. ‖ Three under 4 inches. ¶ Two under 3 inches. ** One 38 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. *May 21. 1⅝ hours.	Thornback skate,	.	2	1	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	8†
	Lemon soles,	.	.	.	2	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	5
	Common dabs,	.	4	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Witch soles,	.	.	.	.	4	8	16	10	10	7	7	.	.	.	.	.	.	.	.	.	62
	Long rough dabs,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Black soles,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	2
	Haddocks,	.	.	.	.	.	11	16	7	.	.	.	1	.	.	.	1	.	.	.	.	36
	Whitings,	.	.	.	.	2	5	.	1	1	.	.	.	.	.	.	.	.	.	.	.	9
	Gurnards,	.	.	.	4	6	.	.	3	.	.	1	1	.	.	.	.	.	.	.	.	15
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	4
	Hake,	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	1	4
	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						158
Sept. 29. 11.50 a.m. to 1.43 p.m.	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3
	Cuckoo rays,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	1	.	1	1	.	1	1	.	.	.	.	3	.	.	.	.	.	.	.	.	8
	Spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Gurnards,	.	3	6	.	3	3	3	.	4	.	1	.	.	.	.	.	.	.	.	.	23
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Hake,	.	.	.	.	.	3	.	.	7	.	.	.	.	.	.	.	.	.	.	.	10
	Brassies,	.	9	12	15	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48
	Whitings,	.	.	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Haddocks,	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	3
	Black soles,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	24	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	42
																						147
*Sept. 29. 7.10 p.m. to 9.5 p.m.	Hake,	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	5	.	1	1	.	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						13
Station VIII.																						
1897. *April 26. 1⅝ hours.	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Common dabs,	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Witch soles,	.	.	.	3	4	10	8	8	19	1	2	.	1	.	.	.	.	.	.	.	56
	Long rough dabs,	.	.	.	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Black soles,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	1	4
	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	5	10	3	.	.	.	1	.	.	.	1	.	.	.	.	.	20
	Gurnards,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2§
	Hake,	.	.	.	.	.	.	5	.	6	.	.	.	.	.	.	.	.	.	.	.	11
	Brassies,	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																						109
April 27. 1¾ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Raia maculata,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Lemon soles,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	1	.	4	3	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10
	Witch soles,	.	.	.	1	9	20	8	23	23	7	15	.	.	2	.	.	.	.	.	.	108
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Long rough dabs,	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Haddocks,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	3
	Whitings,	.	.	.	.	.	3	3	2	.	1	.	.	.	.	.	.	.	.	.	.	9
	Gurnards,	.	.	.	.	2	3	6	5	17	5	4	1	1	.	.	.	.	.	.	.	44
	Anglers,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2‖
	Hake,	.	.	.	.	.	.	.	10	13	4	.	.	.	1	.	.	.	.	1	.	¶31
	Brassies,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						217

* Hauls made at night. † One under 4 inches. ‡ 28 inches. § One 36 inches. ‖ One 29 inches. ¶ One 30 and one 43 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT—II. FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 17. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	1	22	39	28	32	51	25	6	3	1	.	.	.	.	.	.	.	208
	Sail flukes,	.	.	.	.	.	.	1	1	3	1	5	3	1	.	.	.	.	.	.	.	15
	Long rough dabs,	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Black soles.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	2
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Haddocks,	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whitings,	.	.	.	.	4	3	1	2	2	.	.	.	.	.	.	.	.	.	.	.	12
	Gurnards,	.	.	.	8	14	7	6	3	6	1	.	.	.	.	.	.	.	.	.	.	45
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Hake,	.	.	.	.	.	.	.	1	3	.	1	.	.	.	1	.	.	.	.	.	7†
																						302
*May 20. 1½ hours.	Thornback skate.	.	.	1	.	.	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	6‡
	Witch soles,	.	.	.	4	17	28	24	20	23	5	3	2	.	.	.	.	.	.	.	.	126
	Sail flukes,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Red gurnards,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
	Hake,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
																						142
Sept. 29. 7.50 a.m. to 9.40 a.m.	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2‖
	Thornback skate,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	3
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	3	.	.	1	.	.	.	.	.	.	4
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Hake,	.	.	.	.	.	3	2	.	1	.	2	.	1	1	.	.	.	.	.	.	**12
	Whitings,	.	.	1	.	.	3	2	3	.	.	.	.	.	.	.	.	.	.	.	.	9
	Haddocks,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Argentines,	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Gurnards,	.	.	1	.	5	2	2	3		9	.	.	.	.	.	.	.	.	.	.	30
	Witch soles,	1	1	1	2	6	.	10	.	6	2	.	1	.	.	.		.	.	.	.	30
																						96
*Sept. 29. 10.30 p.m. to 12.20 p.m.	Thornback skate,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Whitings,	.	.	.	.	.	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	5
	Brassies,	.	1	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Poor-cod,	.	2	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Sea-bream,	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
	Sail flukes,	.	.	.	.	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	11
	Witch soles,	.	1	.	.	1	.	1	4	6	.	.	3	.	.	.	.	.	.	.	.	16
	Long rough dabs,	.	1	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
																						58
Station IX. 1897. April 22. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.		.	.	1	.	.	1	.	.	.	1	1	1	‡‡3
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	1	3	12	30	23	19	38	15	19	6	1	1	.	.	.	.	.	.	168
	Long rough dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Com. gurnards,	.	.	.	9	4	2	14	12	2	2	1	1	.	.	.	.	.	.	.	.	47
	Red gurnards,	.	.	.	.	.	.	.	.	.	3	.	.	1	.	1	.	.	.	.	.	5
	Hake,	.	.	.	.	.	.	.	14	22	.	3	.	.	.	.	.	.	.	.	.	39
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2	1	.	5
																						278

* Hauls made at night. † One 34 inches. ‡ One under 4 inches. § 30 inches. ‖ One 40 inches. ¶ 28 inches. ** One 30, one 40 inches. †† Over 40 inches. ‡‡ One under 4 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 17. 1⅝ hours.	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Thornback skate,	.	.	.	1	.	.	.	.	.	1	1	.	.	1	1	1	.	.	.	.	6
	Common dabs,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	2	16	15	48	13	12	12	6	2	1	.	.	.	.	.	.	127
	Sail flukes,	.	.	.	.	.	1	2	1	.	1	3	1	.	.	.	.	.	1	.	.	10
	Long rough dabs,	.	1	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Black soles,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Haddocks,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	1	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Gurnards,	.	.	7	15	14	8	6	.	.	5	.	.	.	.	.	.	.	.	.	.	55
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	3	1	6
	Hake,	.	.	.	.	.	.	.	1	10	.	.	.	.	1	.	.	.	.	1	.	13
																						233
Sept. 28. 1.35 p.m. to 3.30 p.m.	Thornback skate,	.	.	.	.	.	1	.	.	.	4	.	.	1	.	.	.	.	1	1	.	8
	Cuckoo rays,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Gurnards,	.	.	2	6	3	3	.	.	3	.	.	.	.	.	.	.	.	.	.	.	17
	Red gurnards,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Hake,	.	.	.	.	2	.	4	.	4	.	.	.	.	.	.	.	.	.	.	.	11†
	Sail flukes,	.	.	.	.	.	.	.	1	1	1	1	.	1	.	.	.	.	.	.	.	5
	Witch soles,	.	.	.	.	4	6	6	7	.	.	.	1	.	.	.	.	.	.	.	.	24
	Whitings,	.	.	.	.	.	6	.	3	1	.	.	.	.	.	.	.	.	.	.	.	10
																						78
Station X. 1897.																						
April 28. 1⅝ hours.	Thornback skate,	.	.	.	.	1	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	5
	Lemon soles,	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	.	2	1	1	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Witch soles,	.	.	.	2	8	4	2	10	24	20	19	6	2	.	.	.	.	.	.	.	97
	Sail flukes,	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	4	11	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
	Black soles,	.	.	.	.	.	.	1	.	.	.	2	1	.	.	1	.	.	.	.	.	5
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Haddocks,	.	.	.	.	.	4	2	.	.	1	.	.	.	.	.	.	.	.	.	.	7
	Whitings,	.	.	.	.	1	1	2	1	1	2	.	.	.	.	.	.	.	.	.	.	8
	Gurnards,	.	1	11	11	14	8	6	9	4	2	.	1	.	.	.	.	.	.	.	.	67
	Red gurnards,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
	Hake,	.	.	.	.	.	.	.	5	3	4	3	.	.	1	.	.	.	.	.	.	16
	Brassies,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
																						245
May 22. 1⅝ hours.	Thornback skate,	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	.	.	5§
	Plaice,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	3	10	11	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28
	Witch soles,	.	.	.	.	5	.	14	14	20	20	10	6	.	.	.	.	.	.	.	.	89
	Long rough dabs,	2	19	41	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	68
	Black soles,	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	2
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	5	3	.	.	.	.	.	.	.	.	.	.	.	.	8
	Whitings,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Gurnards,	.	2	11	12	.	4	.	2	.	1	.	.	.	.	.	.	.	.	.	.	32
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3‖
	Hake,	.	.	.	.	.	.	2	1	9	.	5	2	.	.	2	2	.	1	1	1	¶28
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
																						271

* 36 inches. † One 35 inches. ‡ 50 inches. § Two under 4 inches. ‖ One 27, one 32 inches. ¶ Two 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Sept. 15. 11.55 a.m. to 1.45 p.m.	Cuckoo rays,	.	2	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	5
	Thornback skate,	2	.	.	.	1	.	.	.	1	1	.	.	.	.	.	1	.	.	.	1	7
	Haddocks,	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	3
	Hake,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	2
	Gurnards,	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Witch soles,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Zeugopterus punctatus,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						28
Station XI. 1897. April 21. 1¾ hours.	Thornback skate,	1	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	6*
	Plaice,	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	1	.	.	5
	Lemon soles,	.	.	.	1	1	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	6
	Common dabs,	1	2	9	11	5	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	32
	Flounders,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	1	1	4	4	3	5	4	3	1	5	2	.	.	.	.	.	.	.	33
	Long rough dabs,	1	7	30	13	12	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	69
	Haddocks,	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whitings.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	4
	Com. gurnards,	.	.	.	.	2	3	5	2	4	.	.	.	.	.	.	.	.	.	.	.	16
	Trigla lineata,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	1	14	1	.	3	1	.	1	.	1	.		4	1	30†
	Brassies,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																						208
May 20. 1¾ hours.	Thornback skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3‡
	Plaice,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon soles,	.	.	.	2	.	2	1	2	1	.	.	1	.	.	.	.	.	.	.	.	9
	Common dabs,	1	2	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Witch soles,	.	.	.	3	.	3	10	5	2	3	10	3	.	.	.	.	.	.	.	.	39
	Long rough dabs,	.	2	9	18	4	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	36
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
	Gurnards,	.	2	.	5	1	.	3	.	1	.	.	.	.	.	.	.	.	.	.	.	12
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	1	.	.	1	.	5
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																						117
Sept. 27. 10.50 a.m. to 12.25 p.m.	Thornback skate,	.	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	5
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‖
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Saithe,	.	.	.	.	5	12	6	3	4	23	.	2	.	1	.	.	.	.	.	.	¶57
	Hake,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	1	2	3	2	.	5	8	.	1	.	.	.	.	.	.	.	.	.	22
	Whitings,	.	.	.	1	.	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	5
	Plaice,	.	.	.	.	1	.	.	.	.	2	2	.	.	.	1	.	.	.	.	.	6
	Witch soles,	.	.	.	.	5	9	14	10	8	5	1	.	.	.	.	.	.	.	.	.	52
	Lemon soles,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	4	10	4	5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	25
	Common dabs,	.	.	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
																						187
Station XII. 1897. April 21. 2½ hours.	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2
	Common dabs.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	1	.	1	.	4	.	5	8	12	29	10	5	1	.	.	.	.	.	.	76
	Long rough dabs,	.	9	27	23	8	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	69
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Gurnards,	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	1	1	.	.	.	1	6	5	.	1	.	1	1	.	.	.	.	1	††20
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	‡‡3
																						176

* One under 4 inches. † One 28, one 30, one 31 inches. ‡ One under 4, one 43 inches. § One 36 inches. ‖ One 4 feet 11 inches. ¶ One 28 inches. ** 28 inches. †† One 30, one 31 inches. ‡‡ One 44 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. *April 28. 2 hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
	Witch soles,	.	.	1	.	.	.	6	2	3	16	18	18	6	.	.	.	.	.	.	.	70
	Long rough dabs,	.	7	11	18	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
	Whitings,	.	.	.	.	.	.	8	2	.	1	1	.	.	.	.	.	.	.	.	.	12
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2†
	Hake,	.	1	.	.	.	.	1	4	1	3	.	.	.	.	.	.	.	.	1	.	12‡
	Brassies,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						145
May 20. 2 hours.	Grey skate,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	1	2	4	2	1	3	12	6	7	5	.	.	.	.	.	.	.	43
	Long rough dabs,	3	4	24	18	18	11	1	.	.	.	.	.	.	.	.	.	.	.	.	.	79
	Whitings,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2§
	Hake,	.	.	.	2	.	.	.	7	5	3	.	.	.	.	.	.	.	.	.	.	18‖
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
																						149
*May 26. 2 hours.	Grey skate,	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Thornback skate,	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Witch soles,	.	.	.	.	.	2	2	4	4	3	9	2	4	.	.	.	.	.	.	.	30
	Long rough dabs,	.	8	8	61	7	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	89
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	¶2
	Hake,	.	1	2	1	.	.	1	6	.	.	.	1	.	.	.	.	.	.	.	.	**13
																						143
Sept. 24. 1.55 p.m. to 3.55 p.m.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡1
	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Hake,	.	.	.	.	2	.	.	.	2	.	.	.	.	1	.	.	.	.	.	.	§§6
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Gurnards,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	13	24	26	47	23	41	7	3	.	.	.	.	.	.	.	.	184
	Long rough dabs,	1	1	19	50	15	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	91
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	2	.	1	1	2	.	.	.	.	7
																						294
*Sept. 27. 9.30 p.m. to 11.30 p.m.	*Raia fullonica*,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	‖‖2
	Skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Whitings,	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	¶¶4
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	***3
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Witch soles,	.	.	.	7	6	28	31	63	49	47	22	18	.	.	.	.	.	.	.	.	271
	Long rough dabs,	3	.	116	24	33	11	2	.	.	.	.	.	.	.	.	.	.	.	.	.	189
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
																						477
Station XIII. 1897. March 30. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	1	5	3	.	.	.	1	.	1	.	.	.	11
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	.	.	1	.	1	2	.	.	.	.	.	.	.	.	4
	Long rough dabs,	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
																						27

* Hauls made at night. † One 28, one 39 inches. ‡ One 28 inches. § One 45 inches. ‖ One 33 inches. ¶ One 30 inches. ** One 32 inches. †† 4 feet 5 inches. ‡‡ 28 inches. §§ One at 30 inches. ‖‖ One 28 inches. ¶¶ One 28 inches. *** One 30, one 36 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 27. 1½ hours.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	2
	Lemon soles,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	.	1	4	5	1	.	1	.	.	.	.	.	.	.	12
	Long rough dabs,	.	3	2	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Cod,	.	.	1	.	1	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Whitings,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Brassies,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						44
Oct. 11. 11.10 a.m. to 12.20 p.m.	Picked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2*
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	2
	Cuckoo rays,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger eel,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1†
	Cod,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	3
	Haddocks,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Poor-cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon soles,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	.	.	.	4	2	.	1	.	.	.	.	.	.	.	.	7
	Long rough dabs,	.	1	20	9	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38
	Common dabs,	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Hake,	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	3
	Gurnards,	.	2	9	34	8	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	54
	Liparis vulgaris,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	41‡
	Liparis Montagui.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3§
																						166
Dec. 14. 9.40 a.m. to 10.55 a.m.	Cod,	.	.	.	.	.	.	2	5	4	.	.	1	.	.	.	1	.	.	.	.	13
	Whitings,	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	3
	Haddocks,	.	.	.	.	.	.	.	.	2	2	4	.	1	.	.	.	.	.	.	.	9
	Gurnards,	.	.	.	1	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Liparis vulgaris,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17‖
	Aphia pellucida,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶2
	Brassies,	.	.	2	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Conger eel,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Long rough dabs,	.	.	6	20	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31
	Witch soles,	.	.	.	.	.	.	.	.	1	3	1	.	.	.	.	.	.	.	.	.	5
	Nursehound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
																						95
Station XIV.																						
1897. March 30. 1¾ hours.	Plaice,	.	.	.	.	.	.	.	.	10	1	15	7	2	3	1	2	.	.	.	.	41
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	3
	Common dabs,	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	.	.	3	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Whitings,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Butter-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Liparis, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡1
																						60
May 27. 1¾ hours.	Sandy ray,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	1	3	2	1	.	.	.	.	.	.	.	.	7
	Common dabs,	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch soles,	.	.	.	.	.	.	.	1	4	7	3	.	.	.	.	.	.	.	.	.	15
	Long rough dabs,	.	1	2	8	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Haddocks,	.	.	.	.	.	.	.	4	1	2	.	.	.	.	.	.	.	.	.	.	7
	Cod,	.	.	.	1	.	.	1	1	.	.	.	.	1	.	.	1	.	.	.	.	5
	Whitings,	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	.	1	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																						63

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* One 28 inches. † 29 inches. ‡ Twenty-six at 1½ inches, nine at 2½ inches, four at 3 inches. § Two at 1½ inches, one at 2 inches. ‖ Fifteen at 2½ inches, two at 3½ inches. ¶ 3½ inches. ** 30 inches. †† 3½ inches. ‡‡ 3½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Oct. 11.	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
2.45 p.m.	Cod,	.	.	.	.	.	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	6*
to	Whitings,	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
3.55 p.m.	Brassies,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	1	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Lemon soles,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	.	1	1	4	1	1	.	.	.	.	.	.	.	.	8
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Long rough dabs,	.	5	5	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																						52
Dec. 14.	Thornback skate,	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3†
1.25 p.m.	Cod,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Saithe,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
2.25 p.m.	Haddocks,	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3
	Brassies,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	.	3
	Argentines,	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Gurnards,	.	.	.	2	9	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	12
	LiparisMontagui,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2
	Long rough dabs,	.	1	6	25	12	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	47
	Witch soles,	.	.	.	.	.	.	.	.	3	2	.	5	9	.	.	.	.	.	.	.	19
																						100
Station XV.																						
1897. March 30.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
$1\frac{7}{12}$ hours.	Plaice,	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	.	.	.	.	.	4
	Lemon soles,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch soles,	.	.	.	.	2	5	9	16	41	43	10	4	1	.	.	.	.	.	.	.	131
	Long rough dabs,	.	12	29	44	24	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	116
	Whitings,	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	1	.	.	4
																						265
May 27.	Plaice,	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	2
$1\frac{5}{12}$ hours.	Common dabs,	.	.	1	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Witch soles,	.	.	.	.	.	.	4	9	13	22	13	10	2	.	.	.	.	.	.	.	73
	Long rough dabs,	.	4	8	27	35	24	.	1	.	.	.	.	.	.	.	.	.	.	.	.	99
	Cod,	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	1	3
	Lythe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	2
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Gurnards,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	3
	Brassie,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						192
Oct. 8.	Witch soles,	.	.	.	.	1	8	12	21	53	30	19	8	.	.	.	.	.	.	.	.	152
2.5 p.m.	Plaice,	.	.	.	.	.	.	.	.	2	3	7	1	.	.	.	.	.	.	.	.	13
to	Long rough dabs,	3	3	50	38	55	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	162
3.30 p.m.	Common dabs,	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cod,	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	3
	Haddocks,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2
	Whitings,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
																						339

* One at 35 inches. † One 35 inches. ‡ 27 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT—II. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
1897. Dec. 14. 1.25 p.m. to 2.55 p.m.	Cod,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	3	20	16	11	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	55
	Witch soles,	.	.	.	.	2	4	3	18	7	5	4	.	.	.	.	.	.	.	.	.	43
																						104
Station XVI.																						
1897. March 29. 2¼ hours.	Witch soles,	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						5
May 28. 2¾ hours.	Witch soles,	.	.	.	.	2	6	4	5	4	.	5	.	3	.	.	.	.	.	.	.	29
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2*
																						31
Oct. 8. 10.35 a.m. to 12.40 p.m.	Witch soles,	.	.	.	.	.	.	1	2	3	2	.	.	.	.	.	.	.	.	.	.	8
	Lumpsucker,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						9
Dec. 13. 2½ hours.	Witch soles,	.	.	.	.	.	.	1	1	1	4	.	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						8
Station XVII.																						
1897. March 29. 1½ hours.	Plaice,	.	.	.	.	.	.	.	.	.	.	2	3	6	.	1	.	.	.	.	.	12
	Lemon soles,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	3	4	.	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Witch soles,	.	.	.	.	1	.	.	3	3	14	3	.	1	.	.	.	.	.	.	.	25
	Long rough dabs,	1	2	2	4	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Cod,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2†
	Whitings,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lythe,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	2	5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Hake,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						85
May 28. 1¾ hours.	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	2
	Lemon soles,	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch soles,	.	.	.	.	3	.	10	25	32	24	18	12	.	.	.	.	.	.	.	.	124
	Long rough dabs,	.	.	2	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2
	Saithe,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2§
																						144
Oct. 6. 9.10 a.m. to 10.40 a.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	.	3	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	.	.	.	.	.	.	.	.	.	4	3	1	1	1	.	.	.	.	.	.	10
	Witch soles,	.	.	.	1	1	8	8	11	17	19	6	3	6	.	.	.	.	.	.	.	80
	Common dabs,	1	5	.	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Long rough dabs,	.	10	45	7	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	72
	Lemon soles,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
																						185

* One 28 inches. † One at 33 inches. ‡ 30 inches. § 2½ inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT—II. FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Dec. 11. ¾ hour.	Cod,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	2
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	2	1	2	.	.	.	1	.	.	.	.	6
	Witch soles,	.	.	.	.	.	.	.	1	3	5	3	.	.	.	.	.	.	.	.	.	12
	Common dabs,	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	1	3	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Zeugopterus, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Gobius, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2†
	Aphia pellucida,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
																						42

* 2½ inches. † 2¼ inches. ‡ 3½ inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VI. MORAY FIRTH.

Station, Date, and Time Trawl down.	Kind of Fish	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station V. 1897. June 15. 30 minutes	Lemon soles, .	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs, .	17	6	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39*a*
	Solenette, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*b*
	Whitings, . .	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards, . .	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						43
Station VII. 1897. June 10. 30 minutes	Lemon soles, .	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs, .	4	4	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17*c*
	Long rough dabs,	10	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15*d*
	Zeugopterus, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*e*
	Whitings, . .	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards, . .	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3*f*
	Hake, . . .	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Four Bearded Rockling,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet, . .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pogges, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*g*
	Hag-fish, . .	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
																						48
Nov. 11. 30 minutes	Angler-fish, .	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2
	Gurnards, . .	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*h*
	Dragonets, .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*i*
	Three-Bearded Rockling, .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Agonus cataphractus,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*j*
	Plaice, . .	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	4
	Common dabs, .	7	53	38	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	119*k*
	Lemon soles, .	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	2	22	29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	57*l*
																						201
Station IX 1897. June 10. 30 minutes	Common dabs, .	20	10	13	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	130*m*
	Long rough dabs,	6	.	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14*n*
	Gurnards, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*o*
	Pogge, . .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*p*
																						149
Nov. 9. 30 minutes	Cod, . . .	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake, . .	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*q*
	Gurnards, . .	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*r*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*s*
	Dragonets, .	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Pogge, . .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*t*
	Witch soles, .	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Common dabs, .	17	11	8	8	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
	Long rough dabs,	9	18	11	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46*u*
	Lemon soles, .	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						119
Station XI. 1897. Nov. 22 30 minutes	Cod, . . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*v*
	Gadus minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*w*
	Haddocks, . .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*x*
	Anglers, . .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles, .	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs, .	.	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						17

a Three at 2½, ten at 3½ inches. *b* 3½ inches. *c* Two at 2½, five at 3½ inches. *d* Four at 3½ inches. *e* 2½ inches. *f* One 3½ inches. *g* One 2½, two 3½ inches. *h* Two at 2½, four at 3½ inches. *i* Three at 3½ inches. *j* Two at 3½ inches. *k* Two at 2½ inches. *l* Four at 2½ inches. *m* Thirty-one between 2 and 3, and fifty between 3 and 4 inches. *n* Two at 3½ inches. *o* 3½ inches. *p* One 2½, one 3½ inches. *q* One 2½, five at 3½ inches. *r* One at 2½, one at 3½ inches. *s* 2½ inches. *t* Two at 3½ inches. *u* One at 2½, four at 3½ inches. *v* 3½ inches. *w* Two at 2½, two at 3½ inches. *x* 2½ inches. *y* One at 30 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VI. MORAY FIRTH—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XVI. 1897.																						
June 11. 30 minutes	Lemon soles,	2	2	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	7
	Common dabs,	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6*a*
	Long rough dabs,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Zeugopterus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*b*
	Brassies,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						17

VII. CLYDE.

Station, Date, and Time Trawl down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station V. 1897.																						
April 21. 30 minutes	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	.	.	3	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dabs,	12	13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	44*c*
	Gurnards (com.),	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Brassies,	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12*d*
	Poor Cod,	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonet,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*e*
																						73
May 20. 30 minutes	Lemon soles,	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Common dabs,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*j*
	Long rough dabs,	3	6	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18*g*
	Brassies,	41	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	44*h*
	Gurnards,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*i*
	Dragonets,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*j*
																						76
Sept. 24. 12.5 a.m. to 12.35 a·m.	Hake,	.	.	.	.	.	.	.	.	.	1	2	1	.	.	.	.	.	.	.	.	4
	Brassies,	.	12	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30
	Gadus minutus,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	1	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Long rough dabs,	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Lemon soles,	1	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonets,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10*k*
Station VIII. 1897.																						69
April 27. 30 minutes	Witch soles,	.	.	.	.	2	3	3	.	1	2	.	.	.	.	.	.	.	.	.	.	12*l*
	Long rough dabs,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19*m*
	Whitings,	.	.	.	.	.	3	3	.	.	1	.	.	.	.	.	.	.	.	.	.	7
	Gurnards,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Poor cod,	3	6	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Dragonets,	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*n*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*o*
	Argentine,	.	2	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Four Bearded Rockling,	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						73
May 17. 30 minutes	Common dabs,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	2	3	2	1	3	3	.	.	1	.	.	.	.	.	.	.	.	15
	Long rough dabs,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*p*
	Whitings,	.	.	.	.	1	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	5
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Poor cod,	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Brassies,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonet,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*q*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*r*
	Argentine,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						47

a One 3½ inches. *b* One 3½ inches. *c* Eight at 2½ inches, ten at 3½. *d* Five at 3½ inches. *e* 3½ inches. *f* Two at 2½ inches *g* Four at 3½ inches. *h* Three at 3½ inches. *i* 44 inches. *j* One at 2½ inches. *k* One at 2½, eight at 3½ inches. *l* One at 3½ inches. *m* Fourteen at 2½, and five at 3½ inches. *n* Two 2½, and four 3½ inches. *o* 2½ inches. *p* Two at 2½, one at 3½ inches. *q* Three at 2½, and five at 3½ inches. *r* Two at 2½, and one at 3½ inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VII. CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. Sept. 29. 10 20 a.m. to 10.50 a.m.	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	3	2	.	1	.	.	.	.	.	6
	Thorn-back skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	2
	Dragonet,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*a*
	Hake,	.	.	.	.	2	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Gurnards,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	21	2	.	.	1	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.	60*b*
	Brassies,	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Poor cod,	51	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	179*c*
	Argentines,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*d*
	Aphia pellucida,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*e*
	Long rough dabs,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7*f*
	Witch soles,	.	.	.	.	1	1	3	2	.	3	1	.	.	.	.	.	.	.	.	.	11
																						284
Station IX. 1897. April 22. 30 minutes	Witch soles,	.	.	.	1	.	2	3	1	1	.	.	.	1	.	.	.	.	.	.	.	9
	Long rough dabs,	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11*g*
	Whitings,	.	.	.	2	.	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Gurnards (com.),	.	2	1	1	3	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	11
	Hake,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor cod,	6	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14*h*
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Dragonets,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*i*
	Gobius niger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*j*
	Argentina sphyraena,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						68
May 17. 30 minutes	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Sail fluke,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	2	4	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Gurnards,	.	3	4	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10
	Brassies,	32	24	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65*k*
	Poor cod,	9	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18*l*
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Dragonets,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*m*
	Argentine,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						119
Sept. 28. 3.55 p.m. to 4.25 p.m.	Haddock,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Brassies,	3	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Poor cod,	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*n*
	Hake,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonets,	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18*o*
	Sail flukes,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Solenettes,	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Cuckoorays,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						51
Station X. 1897. April 28. 30 minutes	Witch soles,	.	.	.	.	3	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26*p*
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Poor cod,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*q*
	Dragonet,	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19*r*
	Gobius niger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*s*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*t*
	Four - bearded rockling	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						67

a 3½ inches. *b* Eight at 2½, twenty at 3½ inches. *c* 119 at 3½ inches. *d* One at 3½ inches. *e* 3½ inches. *f* Six at 3½ inches. *g* Seven at 3½ inches. *h* Four at 3½ inches. *i* Three at 3½ inches. *j* 2½ and 3½ inches. *k* Two at 3½ inches. *l* One at 3½ inches. *m* Three at 2½ inches. *n* One at 3½ inches. *o* Thirteen at 3½ inches. *p* Seven at 2½, ten at 3½ inches. *q* Two at 3½ inches. *r* Six at 2½, five at 3½ inches. *s* One at 2½, three at 3½ inches. *t* 2½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VII. Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 22. 30 minutes	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2*a*
	Common dabs, .	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch soles, .	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	1	.	.	3
	Long rough dabs,	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24*b*
	Whitings, . .	.	.	1	.	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	5
	Hake, . .	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	2
	Brassies, . .	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonets, . .	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*c*
	Gobius niger, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*d*
	Gobius minutus, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*e*
	Four - bearded rockling,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						54
Sept. 15. 2.10 p.m. to 2.45 p.m.	Sail fluke, . .	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles, .	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	7	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13*f*
	Zeugopterus, .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Three - bearded rockling,	.	1	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Hake, . . .	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Gurnards, . .	.	4	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*g*
	Gobius minutus, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*h*
	Dragonets, . .	25	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	125*i*
	Argentines, .	.	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						168
Station XII. 1897. Apr. 21. 30 minutes	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*j*
	Witch soles, .	3	1	.	2	.	.	.	2	1	1	.	1	.	.	.	.	.	.	.	.	14*k*
	Long rough dabs,	11	1	3	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32*l*
	Gurnard (com.),	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake, . .	.	1	4	.	.	.	.	.	12	1	.	.	.	.	.	.	.	.	.	.	19*m*
	Brassie, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*n*
	Poor cod, . .	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Lumpenas lampetræformis,	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Motella cimbria, .	.	.	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
																						90
May 20. 30 minutes	Witch soles, .	1	1	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	5
	Long rough dabs,	2	2	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	51*o*
	Whitjngs, . .	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Poor cod, . .	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*p*
	Hake, . .	.	3	2	.	.	.	.	5	3	.	.	1	.	.	.	.	.	.	.	.	14
	Anglers, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	2
	Lumpenus lampetræformis,	.	1	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Four - bearded rockling,	.	2	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*q*
	Ctenolabris rupestris,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*r*
																						100
Sept. 24. 4.40 p.m. to 5.10 p.m.	Gurnards, . .	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Hake, . .	.	.	.	1	7	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	11
	Three - bearded rockling,	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Argentines, .	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whitings, . .	7	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	15*s*
	Gadus minutus, .	48	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	83*t*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*u*
	Witch soles, .	.	2	1	5	8	6	.	5	2	.	.	.	.	.	.	.	.	.	.	.	29
	Long rough dabs,	63	21	32	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	193*v*
																						347

a One at 3½ inches. *b* Eighteen at 3½ inches. *c* One at 2½, three at 3½ inches. *d* 3½ inches. *e* Two at 2½ inches. *f* Two at 3½ inches. *g* 2½ inches. *h* 2½ inches. *i* Five at 2½, and 85 at 3½ inches. *j* 3½ inches. *k* Three at 3½ inches *l* Two at 2½, eight at 3½ inches. *m* One at 3½ inches. *n* 3½ inches. *o* 32 at 2½, eight at 3½ inches. *p* Two at 3½ inches. *q* 2½ inches. *r* 3½ inches. *s* Six at 3½ inches. *t* 32 at 3½ inches. *u* 2½ inches. *v* Two at 1½, and 70 between 3 and 4 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VIII. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Sanda to Bennan Head.																						
Station I.* 1897. Apr. 26.																						
Station II. 1897. Apr. 26. 30 minutes	Sandy ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*a*
	Common dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Zeugopterus, sp.,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Poor cod,	7	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12*b*
	Brassie,	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13*c*
	Gurnards,	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonet,	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*d*
																						38
May 22. 30 minutes	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	1	2	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Common dabs,	.	7	9	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
	Whitings,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Gurnards,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonets,	1	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lesser-spotted dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																						36
Sept. 17. 9.0 a.m. to 9.30 a.m.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Solea lutea,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Zeugopterus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6*e*
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6*f*
	Gadus minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*g*
	Pogge,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*h*
	Dragonets,	9	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	58*i*
	Three-bearded rocklings,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*j*
																						77
Station III. 1897. Apr. 26. 30 minutes	Sandy ray,	1	3	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	7*k*
	Long rough dabs,	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*l*
	Solenettes,	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Zeugopterus, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*m*
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Poor-cod,	9	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26*n*
	Brassie,	6	10	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26*o*
	Gurnards,	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Dragonets,	6	3	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20*p*
																						95
May 22. 30 minutes	Long rough dabs,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whitings,	.	.	.	.	3	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	9
	Gurnards,	.	.	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor cod,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	6	5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16*q*
																						34
Sept. 17. 10.50 a.m. to 11.20 a.m.	*Gadus minutus*,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*r*
	Hake,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	1	10	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28*s*
	Gurnards,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Solea lutea,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Sail flukes,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	96*t*
																						129

* No fish, in consequence of the net being damaged; have decided to cease trawling with shrimp trawl here.

a 3½ inches. *b* One at 3½ inches. *c* Six at 3½ inches. *d* One at 2½ inches. *e* Two at 2½, four at 3½ inches. *f* 3½ inches. *g* 2½ inches. *h* 3½ inches. *i* Twelve at 2½, 36 at 3½ inches. *j* 3½ inches. *k* One at 3½ inches. *l* One 2½, one 3½ inches. *m* 2½ and 3½ inches. *n* Twelve at 3½ inches. *o* Nine at 3½ inches. *p* Two at 2½, eight at 3½ inches. *q* One 2½, one 3½ inches. *r* 2½ inches. *s* 3½ inches. *t* Fifteen at 2½, 60 at 3½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VIII. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station IV. 1897.																						
Apr. 26.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
30 minutes	Common dabs,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	3	2	1	2	8	3	.	.	.	.	.	.	.	.	.	19
	Sail flukes,	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26*a*
	Whitings,	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Poor-cod,	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*b*
	Brassies,	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Gurnards,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36*c*
																						98
Sept. 17.	Argentines,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
12 a.m.	*Gadus minutus*,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*d*
to	*Gobius minutus*,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*e*
12.30 a.m.	*Gobius paganellus*,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*f*
	Whitings,	2	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	8*g*
	Brassies,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6*h*
	Gurnards,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	7*i*
	Three-bearded rockling,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon soles,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27*j*
Station V. 1897.																						63
Apr. 26.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
30 minutes	Common dabs,	1	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch soles,	.	.	.	.	.	2	2	2	.	2	3	1	.	.	.	.	.	.	.	.	12
	Long rough dabs,	4	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19*k*
	Whitings,	.	.	.	.	.	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Poor-cod,	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21*l*
	Brassie,	3	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*m*
	Gurnards,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonets,	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7*n*
	Argentine,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Four-bearded rockling,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	5
	Gobius,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*o*
																						88
May 22.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
30 minutes	Lemon soles,	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	3	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Witch soles,	.	.	.	.	.	.	2	.	2	.	.	3	.	.	.	.	.	.	.	.	7
	Long rough dabs,	6	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11*p*
	Haddocks,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	4
	Gurnards,	1	2	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Dragonet,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*q*
	Gobius, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*r*
																						44
Sept. 17.	Hake,	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
1.7 p.m.	Ling,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
to	Gurnards,	.	.	9	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	12
1.37 p.m.	Whitings,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	3	13	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Argentine,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*s*
	Dragonets,	.	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20*t*
	Long rough dabs,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*u*
	Black soles,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Sail flukes,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*v*
	Lemon soles,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	9	14	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	43
																						103

a Nine at 2½, eight at 3½ inches. *b* One at 3½ inches. *c* Fifteen at 2½, six at 3½ inches. *d* Two at 2½ inches. *e* 2½ inches. *f* 3½ inches. *g* Four at 3½ inches. *h* One at 2½, five at 3½ inches. *i* One at 2½, five at 3½ inches. *j* Sixteen at 2½, nine at 3½ inches. *k* Twelve at 2½, one at 3½ inches. *l* Nine at 3½ inches. *m* One at 3½ inches. *n* One 2½, two 3½ inches. *o* 2½ inches. *p* One 3½ inches. *q* 3½ inches. *r* 3½ inches. *s* 2½ inches. *t* Nine at 3½ inches. *u* 3½ inches. *v* Two at 3½ inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VIII. FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	SIZE IN INCHES.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Corsewall of	Point to Mull Cantyre																					
Station VI. 1897.																						
May 22.	Long rough dabs,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11*a*
30 minutes	Witch soles,	.	.	3	.	2	1	2	2	1	.	1	.	.	.	.	.	.	.	.	.	12
	Whitings,	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	3
	Brassies,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7*b*
	Argentine,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gobius niger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*c*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*d*
																						37
Apr. 26.*																						
May 18.†																						
Sept. 22.	Hake,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
9.55 a.m.	Whitings,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2*e*
to	Brassies,	.	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11*f*
10.27 a.m.	*Gadus minutus*,	.	10	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Haddocks,	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*g*
																						34
Station VII. 1897.																						
Apr. 26.	Black sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
30 minutes	Poor-cod,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						3
May 18.‡ 30 minutes																						
Sept. 22.	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	3
11.50 a.m.	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
to	Whitings,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
12.20 a.m.	Haddocks,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*h*
	Gadus poutassou,	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Gadus minutus,	1	11	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Brassies,	.	12	8	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26*i*
	Lemon soles.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						53
Pladda to	Turnberry Point.																					
Station VIII. 1897.																						
Apr. 28.	Witch soles,	.	.	.	.	.	1	.	2	1	2	.	2	.	.	.	.	.	.	.	.	8
30 minutes	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Long rough dabs,	21	13	7	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	73*j*
	Whitings,	.	.	.	.	.	2	.	1	.	1	.	.	.	.	.	.	.	.	.	.	4
	Poor-cod,	10	13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
	Brassies,	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Four-bearded rockling,	.	.	5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*k*
	Lumpenus lampetræformis,	.	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						130

* No fish; but much mud and many crustacea. † No fish. ‡ No fish.

a Nine 2½, one 3½ inches. *b* Five 2½, one 3½ inches. *c* One 3½ inches. *d* One 2½ inches. *e* One 3½ inches. *f* One 3½ inches

g One 3½ inches. *h* One 3½ inches. *i* Two at 2½ inches. *j* Nine at 2½, 19 at 3½ inches. *k* One 3½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VIII. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
1897. May 26. 30 minutes	Lemon soles,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	.	.	.	2	1	4	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	16	9	6	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	73*a*
	Whiting,	.	.	2	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor-cod,	6	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33
	Brassie,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Hake,	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Lumpenus lampetræformis,	.	.	3	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Gobius, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*b*
	Four-bearded rockling,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*c*
																						131
Sept 28. 11.10 a.m. to 11.40 a.m.	Poor-cod,	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Whiting,	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4*d*
	Brassie,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	27	12	6	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	87*e*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*f*
	Dragonets,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*g*
	Centronotus gunnellus,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						110
Station IX. 1897. Apr. 28. 30 minutes	Common dabs,	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	1	.	.	2	.	1	4	.	.	.	.	.	.	.	.	8
	Long rough dabs,	32	6	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	115*h*
	Whitings,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Poor-cod,	22	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	45*i*
	Brassies,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*j*
	Hake,	.	.	3	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Argentines,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*k*
	Lumpenus lampetræformis,	.	1	6	8	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30
	Dragonet,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*l*
	Gobius, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*m*
	Four-bearded rockling,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Raia oxyrhynchus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2*n*
																						220
May 26. 30 minutes	Witch soles,	.	.	.	1	.	1	.	.	1	1	.	1	.	.	.	.	.	.	.	.	5
	Long rough dabs,	9	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	42*o*
	Zeugopterus, sp.,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*p*
	Poor-cod,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassies,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*q*
	Gobius niger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*r*
	Lumpenus lampetræformis,	.	.	2	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
																						65
Sept. 27. 3.5 p.m. to 3.40 p.m.	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Brassies,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Poor-cod,	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whitings,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Argentines,	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Aphia pellucida,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9*s*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6*t*
	Three-bearded rockling,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonets,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*u*
	Witch soles.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*v*
	Long rough dabs,	23	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	116*w*
	Lumpenus, sp.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						155

a Sixteen at 2½, sixteen at 3½ inches. *b* 2½ inches. *c* One 3½ inches. *d* Two at 3½ inches. *e* Three at 2½, 31 at 3½ inches. *f* 2½ inches. *g* Two at 3½ inches. *h* Thirty-one 2½, forty-one 3½ inches. *i* Sixteen 3½ inches. *j* Two 3½ inches. *k* 3½ inches. *l* Two at 3½ inches. *m* 2½ inches. *n* One 29 inches. *o* Sixteen 2½, twelve 3½ inches. *p* 3½ inches. *q* One 2½, two 3½ inches. *r* 2½ and 3½ inches. *s* Four at 2½, five at 3½ inches. *t* 2½ inches. *u* 2½ inches. *v* 3½ inches. *w* Eleven at 1½, four at 2½, seventy-two at 3½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

A. FISH CAUGHT (*Shrimp Trawl*)—VIII. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station X. 1897. Apr. 28. 30 minutes	Thornback skate,	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon soles, .	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Common dabs, .	14	21	12	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48
	Witch soles, .	.	.	.	.	.	1	.	.	1	2	3	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	26	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	89*a*
	Haddocks, . .	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whitings, . .	.	.	.	.	1	2	1	.	2	.	.	.	.	.	.	.	.	.	.	.	6
	Gurnards, . .	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Hake, . . .	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Angler, . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Brassies, . .	18	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	43*b*
	Dragonet, . .	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*c*
	Four - bearded rockling,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						211
May 26. 30 minutes	Common dabs, .	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles, .	.	.	3	4	2	5	.	5	7	1	1	1	.	.	.	.	.	.	.	.	29
	Long rough dabs,	8	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	41*d*
	Whitings, . .	.	.	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor cod, . .	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*e*
	Brassies, . .	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Gurnards, . .	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake, . . .	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet, . .	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4*f*
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*g*
	Lumpenus lampetræformis,	.	.	6	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
	Four - bearded rockling,	.	.	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Argentine,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*h*
																						112
Sept. 27. 2.15 p.m. to 2.48 p.m.	Hake, . .	.	.	.	3	.	3	.	.	1	1	.	1	.	.	.	.	.	1	.	.	10
	Haddocks, . .	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Brassies, . .	.	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Gobius minutus,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5*i*
	Gurnards, . .	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	3
	Three - bearded rocklings, .	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonets, .	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8*j*
	Witch soles, .	.	.	1	2	7	5	.	2	1	.	.	.	.	.	.	.	.	.	.	.	18
	Long rough dabs,	37	8	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	93*k*
	Common dabs, .	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
																						155

a Twenty-nine at 2½, twenty-nine at 3½ inches. *b* Sixteen at 3½ inches. *c* One at 3½ inches. *d* Eight at 2½, nineteen at 3½ inches.
e 3½ inches. *f* Three at 3½ inches. *g* 2½ inches. *h* 2½ inches. *i* 2½ inches. *j* Six at 3½ inches.
k Six at 1½ inches, thirty-four at 3½ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c., IN THE TRAWL NET—

I. Moray Firth.

Station and Date.	Organisms Captured.
1897. **Station I.** June 9. 1 hour 50 mins.	*Eupagurus bernhardus*, one ; *Porcellana longicornis*, one ; *Galathea*, sp., f., *Asterias rubens*, f. ; *Ophiocoma nigra*, r. ; *Astropecten irregularis*, one ; *Alcyonium digitatum*, f. ; sponge, r. ; a small quantity of weed.
Nov. 8. 2 hours.	*Ascidiella virginea*, v. r. ; *Ascidia*, sp., f. ; *Fusus antiquus*, one ; *Buccinum undatum*, r. ; *Pecten opercularis*, r., young ; *Mytilus modiolus*, f. ; *Mytilus barbatus*, r. ; *Anomia ephippium*, r. ; *Portunus holsatus*, one ; *Hyas coarctatus*, f. ; *Cancer pagurus*, one ; *Inachus dorsettensis*, v. r. ; *Stenorhynchus rostratus*, one ; *Nephrops norvegicus*, two ; *Crangon allmani*, v. r. ; *Eupagurus bernhardus*, f. (with *Hydractinia echinata*) ; *Balanus hameri*, r. ; *Asterias rubens*, r. ; *Solaster endeca*, one ; *Solaster papposa*, one ; *Sertularella rugosa*, m. c. (on fronds of *Laminaria*) ; *Sertularia abietina*, v. r. ; *Hydractinia echinata*, f. ; *Tubularia indivisa*, r. ; a small quantity of *Laminaria Fucus* and other sea-weeds.
Station II. June 9. 2 hours.	Ascidians, f. ; *Eupagurus bernhardus*, r. ; *Galathea*, sp., r. ; *Asterias rubens*, r. ; *Solaster papposa*, one ; *Solaster endeca*, one ; *Alcyonium digitatum*, com. ; a considerable quantity of weed.
Nov. 5. 2 hours.	*Ascidiella virginea*, f. ; *Ciona intestinalis*, v. r. ; *Ascidia*, sp. (?) ; few *Botryllus*, sp. (?), v. r. ; *Botryloides rubrum*, v. r. ; *Fusus antiquus*, r. ; *Buccinum undatum*, v. r. ; *Helcion pellucidum*, r. ; *Turritella terebra*, r. (dead); *Fusus propinquus*, one ; *Pleurotoma*, sp., r. ; *Nassa*, sp. (?) *incrassata*, v. r. ; *Saxcava rugosa*, f. ; *Pholas crispata* (boring in chunks of dead wood), m. c. ; *Pecten opercularis*, f. ; *Dentalium entale*, r. (with a sipunculid) ; *Cyprina islandica*, v. r. (dead) ; *Cancer pagurus*, two ; *Portunus holsatus*, m. c. ; *Hyas coarctatus*, m. c. ; *Inachus dorsettensis*, r. ; *Stenorhynchus rostratus*, two ; *Porcellana longicornis*, m. c. ; *Galathea nexa*, v. r. ; *Galathea dispersa*, m. c. ; *Nephrops norvegicus*, f. ; *Eupagurus bernhardus*, f. ; *Balanus hameri*, f. ; *Balanus*, sp. (?) r. ; *Echinus miliaris*, r. ; *Asterias rubens*, c. (large) ; *Solaster papposa*, one ; *Solaster endeca*, one ; *Ophiothrix fragilis*, few ; *Serpula vermicularis*, f. ; *Polynöe squamata*, f. ; *Polynöe* sp. (?) f. ; *Nereis pelagica*, f. ; *Nereis* sp. (?) f. ; *Flustra papyracea*, f., and other Polyzoa ; *Alcyonium digitatum*, c. (on stones and dead shells) ; *Hydractinia echinata*, f. ; *Tubularia indivisa*, r. ; *Actinoloba dianthus*, one ; *Sertularia abietina*, r. ; *Halecium halecinum*, r., and a few other Hydrozoa ; sponge, sp. (?), v. r.
Station III. June 14. 1 hour 10 mins.	Some *Buccinum* spawn ; *Modiola modiolus*, r. ; *Hyas araneus*, r. ; *Hyas coarctatus*, r. ; *Eupagurus bernhardus*, r. ; *Solaster papposa*, f. ; *Spatangus purpureus*, f. ; *Echinus miliaris*, r. ; *Echinus esculentus*, f. ; *Cucumaria* (?) *frondosa*, fr. ; *Alcyonium digitatum*, f. ; a considerable quantity of weed.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—I. MORAY FIRTH—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. Nov. 6. 1 hour.	*Ascidiella virginea*, f.; *Ascidia aspersa*, f.; *Ascidia depressa*, one; *Ascidia*, sp. (?), f.; *Botryllus*, sp. (?), r.; *Buccinum undatum*, m. c.; *Fusus antiquus*, one; *Capulus hungaricus*, v. r.; *Trochus miligranus*, f.; *Velutina lævigata*, r.; *Turritella terebra*, r. (dead); *Anomia ephippium*, f.; *Cyprina islandica* (dead valves), f.; *Pecten pusio*, f.; *Pecten opercularis*, f.; *Saxicava rugosa*, f.; *Nucula nitida*, r.; *Tellina balthica*, v. r. (young); *Mytilus modiolus*, m. c.; *Mytilus barbatus*, f.; *Tapes pullastra*, v. r.; *Fiona* (?), sp. (?), one; *Hyas coarctatus*, m. c.; *Hyas araneus*, r.; *Stenorhynchus rostratus*, r.; *Nephrops norvegicus*; *Carcinus mænas*, one; *Portunus holsatus*, one; *Eupagurus bernhardus*, f.; *Idotea tricuspidata*, f.; *Arcturus longicornis*, v. r.; *Echinus esculentus*, f.; *Strongylocentrotus dröebachiensis*, abdt. (and very fine specimen, a much depressed form); *Echinus miliaris*, c. r.; *Asterias rubens*, c.; *Solaster papposa*, v. r.; *Solaster endeca*, r.; *Henricia sanguinolenta*, one; *Ophiothrix fragilis*, f.; *Ophiopholis aculeata*, c. (fine); *Cucumaria frondosa*, three large specimens; *Cucumaria lactea* (?), one; *Tubularia indivisa*, f.; *Hydrallmania falcata*, r.; *Sertularia abietina*, abdt. (with *Serpula* and Discorbina); *Plumularia pinnata*, r., and other Hydroids; *Polyzoa*, several species; *Alcyonium digitatum*, abdt.; *Hydractinia echinata*, m. c.; *Serpula triquetra*, f.; *Serpula vermicularis*, f.; *Serpula reversa*, f.; *Polynöe squamata*, f.; *Polynöe*, sp. (?), f.; *Nereis pelagica*, m.c.; *Nereis*, sp. (?), f.; Sponge, sp. (?), one specimen.
Station IV. June 15. 2 hours 5 mins.	*Hyas coarctatus*, f.; *Asterias rubens*, com.; *Solaster papposa*, f.; *Astropecten irregularis*, one; *Alcyonidium*, sp., f.; some zoophytes and a small quantity of sea-weed.
Nov. 11. 2 hours 10 mins.	*Eolis*, sp., one; *Mytilus modiolus*, f.; *Mytilus edulis*, f.; *Circe minima*, one; *Pecten opercularis* (young), rare; *Portunus holsatus*, m. c.; *Hyas coarctatus*, f.; *Hyas araneus*, one; *Hippolyte*, sp. (?), r.; *Eupagurus bernhardus*, one; *Echinocyamus pusillus*, several; Polyzoa, several species; *Hydractinia echinata*, f.
Station V. June 15. 2 hours 35 mins.	*Eupagurus bernhardus*, one; *Asterias rubens*, fr.; *Alcyonidium*, sp., r.; sponges, f.; zoophytes, f.; a small quantity of sea-weed.
Nov. 11. 2 hours 35 mins.	*Ascidiella virginea* (?), abdt. (attached to dead shells); *Tubularia indivisa*, etc.; *Fusus antiquus*, r. (with Eupagurid); *Buccinum undatum*, r.; several colonies of the eggs of *Buccinum*; *Cardium echinatum*, r. (dead); *Cyprina islandicum* (dead valves), r.; *Pecten opercularis*, v. r. (young); *Anomia ephippium*, f.; *Portunus holsatus*, f.; *Hyas coarctatus*, v. r.; *Eupagurus bernhardus*, f.; *Nephrops norvegicus*, one; *Idotea tricuspidata*, f.; *Idotea*, sp. (?), r.; *Echinus esculentus*, f.; *Solaster papposa*, one; *Solaster endeca*, f.; *Ophiura ciliaris*, v. r.; *Serpula vermicularis*, f.; *Serpula triquetra*, r.; *Balanus hameri*, f.; *Balanus*, sp. (?), r.; *Polynöe*, sp. (?), f.; *Tubularia indivisa*, f.; *Alcyonium digitatum* (young colonies on *Tubularia*); *Hydractinia echinata*, m. c.; sponge, sp. (?), one.
Shrimp Trawl. Nov. 11. ½ hour.	*Buccinum undatum*, v. r.; *Pecten opercularis*, v. r. (young); *Mytilus modiolus*, v. r.; *Portunus holsatus*, f.; *Hyas coarctatus*, f.; *Galathea intermedia* v. r.; *Galathea*, sp., v. r.; *Hippolyte*, sp. (?), v. r.; *Eupagurus bernhardus*, r.; *Porcellana longicornis*, f.; *Serpula vermicularis*, f.; *Flustra foliacea*, m. c.; *Flustra papyracea*, r.; *Lepralia*, sp. (?) and other Polyzoa; *Asterias rubens*, r.; *Echinus esculentus*, f.; *Ophiothrix fragilis*, f.; *Tubularia indivisa*, f.; *Alcyonium digitatum*, m. c.; *Hydractinia echinata*, f.; *Amphidotus cordatus*, one.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—I. MORAY FIRTH—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. **Station VI.**	
June 15. 1 hour 45 minutes.	*Fusus antiquus*, f. ; *Eupagurus bernhardus*, r. ; *Asterias rubens*, fr. ; *Solaster papposa*, r. ; *Alcyonium digitatum*, f. ; *Alcyonidium*, sp., r. ; sponges, several specimens.
Nov. 10. 1½ hours.	*Ascidiella virginea* (?), f. ; *Buccinum undatum*, r. (dead) ; *Cyprina islandica*, r. (dead valves) ; *Solen pallucida*, one ; *Portunus holsatus*, r. (with *Sacculina carcini* ?) ; *Hyas coarctatus*, r. ; *Galathea dispersa*, v. r. ; *Inachus dorsettensis*, v. r. ; *Eupagurus bernhardus*, f. ; *Asterias rubens*, abdt. ; *Solaster endeca* ; *Ophiura ciliaris*, v. r. ; *Echinus esculentus*, f. ; *Flustra papyracea*, m. c., and other Polyzoa ; *Hydractinia echinata*, m. c.
Station VII.	
June 10. 2 hours.	*Buccinum undatum* (one or two large clusters of spawn) ; *Eupagurus bernhardus*, r. ; *Galathea*, sp., r. ; *Asterias rubens*, f. ; *Solaster papposa*, r. ; *Solaster endeca*, r. ; *Cucumaria* (?) *frondosa*, one ; zoophytes, r.
Nov. 10. 1 hour 47 minutes.	*Ascidiella virginea* (?), c. ; *Eledone cirrosa*, two ; *Buccinum undatum* (with Pagurids), f. ; *Portunus holsatus*, r. (with *Saculina carcini*) ; *Hyas coarctatus* ; *Eupagurus bernhardus*, f. ; *Eupagurus prideauxii*, f. (with *Adamsia palliata*) ; *Inachus dorsettensis*, one ; *Asterias rubens*, c. (large) ; *Flustra papyracea*, m. c., and other Polyzoa ; *Serpula vermicularis*, f. ; *Serpula triquetra*, v. r. ; *Priapulus caudatus*, one ; *Tubularia indivisa*, r. ; *Sertularia argentea*, v. r. ; *Alcyonium digitatum* (young colonies on *Tubularia indivisa*), f.
Shrimp Trawl. Nov. 10. ½ hour.	*Ascidiella virginea* (?), c. ; *Eledone cirrosa*, three ; *Buccinum undatum*, r. (with Pagurids) ; *Fusus antiquus*, one ; *Portunus holsatus*, r. ; *Inachus dorsettensis*, one ; *Hyas coarctatus* (young), r. ; *Galathea nexa*, one ; *Nephrops norvegicus*, f. (some carrying nearly ripe eggs) ; *Eupagurus bernhardus*, f. ; *Eupagurus prideauxii*, r. ; *Asterias rubens*, r. ; *Astropecten irregularis*, one ; *Tubularia indivisa*, f. ; *Adamsia palliata*, r. ; *Alcyonium digitatum* (a few colonies) ; *Flustra papyracea*, f. ; *Serpula vermicularis*.
Station VIII.	
June 10. 1 hour 54 minutes.	*Hyas coarctatus*, one ; *Eupagurus bernhardus*, f. ; *Asterias rubens*, f. ; *Solaster papposa*, r. ; *Solaster endeca*, r. ; *Palmipes placenta*, two ; *Echinus esculentus*, one ; *Cucumaria* (?) *frondosa*, two ; *Alcyonium digitatum*, f. ; *Actinoloba dianthus*, fr.
Nov. 9. 2 hours.	*Ascidia mentula*, v. r. ; *Ascidiella virginea* (?) sp., abdt. ; *Polycarpa glomerata* (?), two ; *Polycarpa*, sp. (?), v. r. ; *Pleurotoma*, sp. (?), r. ; *Buccinum undatum*, one ; *Archidoris johnstoni*, v. r. ; *Fiona*, sp. (*marina* ?), one ; *Cardium echinatum*, r. (dead, with Ascidians attached) ; *Portunus holsatus*, one ; *Galathea nexa*, one ; *Galathea intermedia* (?), v. r. ; *Eupagurus bernhardus*, r. ; *Eupagurus prideauxii*, one ; *Eupagurus cuenensis*, one in sponge (?), sp. (*suberites* ?) ; *Serpula vermicularis*, f. ; *Nereis*, sp. (?), f. ; *Polynöe*, sp. (?), r. ; *Planarian*, sp. ? (among Ascidia) ; Polyzoa, several species (?) ; *Adamsia palliata*, one ; *Hydractinia echinata*, r.
Station IX.	
June 10. 1 hour 52 minutes.	*Buccinum undatum*, one ; *Fusus antiquus*, one ; *Fusus gracilis*, one ; *Eupagurus bernhardus*, r. ; *Galathea*, sp., f. ; Ascidians, f. ; *Asterias rubens*, f. ; *Leridia*, sp. (a fragment) ; *Astropecten irregularis*, r. ; *Goniaster phrygianus*, f. ; *Spatangus purpureus*, fr. ; *Echinus esculentus*, one ; *Cucumaria* (?) *frondosa*, two ; *Alcyonium digitatum*, f. ; *Actinoloba dianthus*, r. ; zoophytes, r.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—I. Moray Firth—*continued.*

Station and Date.	Organisms Captured.
1897. Nov. 9. 2 hours.	*Eledone cirrosa*, one ; *Nephrops norvegicus*, f. (some carrying nearly ripe eggs); *Eupagurus cuanensis*, one (in sponge, *Suberites*, sp. ?) ; *Eupagurus bernhardus*, f. ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, f. (large) ; *Adamsia palliata*, f. ; *Actinoloba dianthus* (?), one ; *Pennatula phosphorea*, one ; *Alcyonium digitatum*, v. r. ; *Helecium helecinum*, one colony, and a few Polyzoa.
Shrimp Trawl. Nov. 9. ½ hour.	*Eledone cirrosa*, one ; *Nephrops norvegicus*, f. (some with eggs) ; *Eupagurus cuanensis* (in sponge sp. ?), one ; *Eupagurus prideauxii*, f. ; *Eupagurus bernhardus*, f. ; *Asterias rubens*, f., large ; *Ophiura albida*, one ; *Actinoloba dianthus* (?), one ; *Pennatula phosphorea*, one ; *Helecium helecinum*, r., and another Hydrozoa sp. (?) ; *Flustra papyracea*, f., and a few other Polyzoa, sp. ; *Adamsia palliata*, f. ; *Hydractinia echinata*, f.
Station X. June 10. 1 hour 52 minutes.	Ascidians, r. ; *Eupagurus bernhardus*, r. ; *Eupagurus prideauxii* (with *Adamsia palliata*), r. ; *Porcellana longicornis*, f. ; *Asterias rubens*, fr. ; *Solaster endeca*, r. ; *Goniaster phrygianus*, f. ; *Palmipes placenta*, one ; *Astropecten irregularis*, one ; *Actinoloba dianthus*, f. ; a small quantity of sea-weed.
Nov. 8. 1½ hours.	*Ascidiella virginea*, v. r. ; *Ascidia*, sp. (?), f.; *Fusus antiquus*, one; *Pecten opercularis* (young), v. r. ; *Stenorhynchus rostratus*, one ; *Inachus dorsettensis*, v. r. ; *Nephrops norvegicus*, two ; *Portunus holsatus*, one ; *Eupagurus bernhardus*, v. r. ; *Asterias rubens*, one ; *Solaster papposa*, v. r. ; *Pennatula phosphorea*, one ; *Actinoloba dianthus* (?), one ; *Hydractinia echinata*, v. r. ; a quantity of *Fucus* was brought up in the trawl at this station.
Station XI. June 11. 1 hour 50 minutes.	*Triton hombergi*, one ; *Pecten opercularis*, one ; *Fusus antiquus*, one ; *Modiola modiolus*, f. ; *Eupagurus bernhardus*, r. ; *Asterias rubens*, f. ; *Echinus esculentus*, f. ; *Cucumaria* (?) *frondosa*, several ; *Goniaster phrygianus*, f. ; *Spatangus purpureus*, one ; *Alcyonium digitatum*, fr. ; zoophytes, f.
Nov. 22. 2 hours.	*Ascidiella virginea* (?), m. c. ; *Eledone cirrosa*, one ; *Sepiola atlantica*, one ; *Fusus islandicus*, v. r. (with Eupagurid) ; *Buccinum undatum*, r. ; *Pecten opercularis*, f. ; *Anomia ephippium*, f. ; *Cyprina islandica*, valves (with boring sponge), r. ; *Portunus holsatus*, f. ; *Portunus depurator* (?), one ; *Hyas coarctatus*, v. r. ; *Hyas araneus*, one, ♀. ; *Inachus dorsettensis*, f. ; *Galathea dispersa*, v. r. ; *Galathea* sp. (?), f. ; *Eupagurus prideauxii*, r. ; *Eupagurus bernhardus*, f. ; *Echinus esculentus*, f. ; *Spatangus purpureus*, one ; *Cucumaria frondosa*, one ; *Asterias rubens*, f. ; *Solaster papposa*, one ; *Ophiura ciliaris*, one ; *Ophiothrix fragilis*, v. r. ; *Serpula triquetra*, f. ; *Serpula vermicularis*, r. ; *Flustra foliacea*, r. ; *Flustra papyracea*, f. ; *Polynöe*, sp., r. ; *Membranipora pilosa*, r., and other Polyzoa ; *Adamsia palliata*, r. ; *Alcyonium digitatum*, m. c. ; *Hydractinia echinata*, m. c. ; *Sertularia pumila*, v. r. ; *Sertularia abietina*, r. ; *Halecium halecinum*, r. ; *Campanularia verticillata*, c. ; *Halecium muricatum*, f., and other Hydrozoa.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—I. MORAY FIRTH—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. Shrimp Trawl. Nov. 22. 38 minutes.	*Ascidiella virginea* (?), f. ; *Eledone cirrosa*, two ; *Sepiola atlantica* (?), f. ; *Fusus antiquus*, one ; *Fusus islandicus*, f. (dead, with Eupagurids) ; *Trochus zizyphinus*, m. c. ; *Buccinum undatum*, m. c. ; *Natica alderi*, v. r. ; *Eulima polita*, one ; *Capulus hungaricus*, v. r. ; *Dentalium entale*, v. r. ; *Mytilus modiolus*, one ; *Pecten opercularis*, f. ; *Pecten tigrinus*, one ; *Anomia ephippium*, f. ; *Solen pellucidus*, one ; *Portunus holsatus*, r. ; *Pandalus annulicornis*, one ; *Hippolyte*, sp. (?), one ; *Galathea dispersa*, one ; *Galathea intermedia*, f. ; *Inachus dorsettensis*, f. ; *Stenorhynchus rostratus*, f. ; *Hyas coarctatus*, v. r. ; *Eupagurus cuanensis*, m. c. ; *Eupagurus prideauxii*, r. ; *Eupagurus bernhardus*, f. ; *Balanus hameri*, f. ; *Balanus balenoides*, r. ; *Echinus esculentus*, f. ; *Strongylocentrotus droebachiensis*, f., young ; *Asterias rubens*, r. ; *Solaster papposa*, one ; *Ophiothrix fragilis*, f. ; *Ophiura ciliaris*, one ; *Ophiura albida*, one ; *Astropecten irregularis*, one ; *Flustra foliacea*, f. ; *Flustra papyracea*, f. ; *Membranipora pilosa*, r. ; *Membranipora membranacea*, f. ; *Cellaria fistulosa*, v. r., and other Polyzoa ; *Serpula triquetra*, f. ; *Serpula vermicularis*, f. ; *Polynöe squamata*, r. ; *Polynöe*, sp. (?), f. and several other Annelids ; *Adamsia palliata*, r. ; *Alcyonium digitatum*, m. c. ; *Hydractenia echinata*, m. c. ; *Tubularia coronata*, v. r. ; *Hydrallmania falcata*, m. c. ; *Sertularia pumila*, v. r. ; *Sertularia abietina*, r. ; *Campanularia verticillata*, m. c. ; *Halecium muricatum*, f. and other Hydrozoa.
Station XII. June 11. 1 hour 50 minutes.	*Pecten opercularis*, one ; *Buccinum undatum*, one (and one or two clusters of spawn) ; *Fusus antiquus*, one ; Ascidians, r. ; *Eupagurus bernhardus*, f. ; *Eupagurus* (?) *cuanensis* (with accompanying sponge), r. ; *Astropecten irregularis*, r. ; *Echinus esculentus*, f. ; *Spatangus purpureus*, r. ; *Cucumaria* (?) *frondosa*, f. ; *Alcyonium* and *Alcyonidium*, several specimens.
Nov. 22. 2 hours.	*Ascidiella virginea* (?), f. ; *Fusus islandicus*, f. (with Eupagurid) ; *Buccinum undatum*, f. ; *Pecten opercularis*, f. ; *Cyprina islandica* (dead valves), f. ; *Solen siliqua*, one (dead) ; *Saxicava rugosa*, r. ; *Anomia ephippium*, f. ; *Tellina incurvata* (?), one (dead) ; *Mytilus modiolus*, f. ; *Mytilus edulis*, v. r. (dead) ; *Portunus holsatus*, r. ; *Portunus depurator*, one ; *Inachus dorsettensis*, f. ; *Galathea intermedia*, r. ; *Eupagurus prideauxii*, f. ; *Eupagurus bernhardus*, f. ; *Balanus hameri*, r. ; *Balanus balenoides*, v. r. ; *Polynöe*, sp., and several other annelids ; *Echinus esculentus*, f. ; *cucumaria frondosa*, three very large specimens ; *Asterias rubens*, f. ; *Hippasterias phrygiana*, one ; *Flustra foliacea*, f. ; *Flustra papyracea*, m. c., and a few other Polyzoa ; *Adamsia palliata*, f. ; *Alcyonium digitatum*, c. ; *Hydractinia echinata*, f. ; *Sertularia abietina*, r. ; *Hydrallmania falcata*, m. c. ; *Campanularia verticillata*, m. c., and other Hydrozoa.
Station XIII. June 11. 1 hour 25 minutes.	*Aporrhaïs pes-pelicani*, one ; *Fusus antiquus*, three ; *Eupagurus bernhardus*, f ; *Eupagurus prideauxii*, r. ; *Asterias rubens*, f. ; *Goniaster phrygianus*, f. ; *Echinus esculentus*, com. ; *Cucumaria* (?) *frondosa*, several.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—I. Moray Firth—*continued.*

Station and Date.	Organisms Captured.
1897. Nov. 20. 2 hours.	*Ascidiella virginea* (?), abdt. *Ascidia*, sp. (?), one; *Sepiola atlantica*, two; *Dentalium entale*, v. r. (dead); *Pleurotoma rufa*, v. r.; *Natica alderi*, one; *Cypræa Europæa*, one; *Buccinum undatum*, r.; *Archidoris tuberculata*, one; *Pecten opercularis*, f.; *Pecten tigrinus*, v. r.; *Mytilus modiolus*, f.; *Saxicava rugosa*, v. r.; *Cyprina islandica* (dead), one; *Cardium echinatum*, r. (dead valves, with ascidians attached); *Tellina crassa* (valves), v. r.; *Portunus holsatus*, r.; *Portunus depurator*, one; *Hyas coarctatus*, f. (young); *Galathea dispersa*, v. r.; *Galathea intermedia*, r.; *Inachus dorsettensis*, f.; *Stenorhynchus rostratus*, f.; *Hippolyte*, sp. (?), v. r.; *Eupagurus prideauxii*, r.; *Eupagurus bernhardus*, f.; *Serpula triquetra*, m. c.; *Serpula vermicularis*, m. c.; *Polynöe cirrata*, v. r.; *Polynöe*, sp. (?), v. r.; *Nereis virens* (?), f.; *Flustra foliacea*, m. c.; *Flustra papyracea*, f.; *Lepralia pallasina* and several other Polyzoa; *Echinus esculentus*, m. c.; *Strongylocentrotus droebachiensis*, r. (small); *Spatangus purpureus*, one; *Cucumaria frondosa*, one; *Asterias rubens*, f.; *Solaster endeca*, one; *Solaster papposa*, one; *Hippasterias phrygiana*, one; *Ophiopholis aculeata*, v. r.; *Ophiothrix fragilis*, v. r.; *Adamsia palliata*, r.; *Alcyonium digitatum*, abdt.; *Tubularia coronata*, v. r.; *Tubularia indivisa* (one colony); *Antennularia ramosa* (one colony); *Antennularia antennina*, f.; *Hydrallmania falcata*, abdt.; *Plumularia pinnata*, f.; *Lafoea dumosa*, f.; *Campanularia verticillata*, abdt., and several other Hydrozoa.
Shrimp Trawl. Nov. 20. ½ hour.	*Ascidiella virginea* (?), f.; *Eledone cirrosa*, one; *Buccinum undatum*, r. (with Eupagurids); *Pecten opercularis*, r.; *Pecten tigrinus*, v. r.; *Cyprina islandica* (valves), r.; *Hyas coarctatus*, f.; *Inachus dorsettensis*, f.; *Portunus holsatus*, r.; *Stenorhynchus rostratus*, r.; *Galathea dispersa*, one; *Eupagurus bernhardus*, r.; *Astropecten irregularis*, one; *Asterias rubens*, one; *Ophiura ciliaris*, one; *Alcyonium digitatum*, f.; *Thuiaria thuja*, r.; *Antennularia antennina*, r.; *Sertularia abietina*, f.; *Hydrallmania falcata*, c.; *Flustra foliacea*, m. c.; *Flustra papyracea*, r.; *Serpula triquetra*, f.; *Serpula vermicularis*, r., and also a few other Polyzoa and Hydrozoa.
Station XIV. June 11. 1 hour 55 minutes.	*Pecten opercularis*, f.; *Buccinum undatum*, r.; *Fusus antiquus*, r.; Ascidians, com.; *Eupagurus bernhardus*, r.; *Galathea*, sp., r.; *Goniaster phrygianus*, f.; *Spatangus purpureus*, f.; *Echinus esculentus*, r.; *Cucumaria* (?) *frondosa*, r.; *Alcyonium digitatum*, f.; zoophytes, r.
Nov. 18. 2 hours.	*Ascidiella virginea* (?), abdt. (attached to Hydroids, dead shells, &c.); *Eledone cirrosa*, one; *Buccinum undatum*, v. r.; *Fusus gracilis*, v. r. (with *Eupagurus*); *Cardium echinatum*, v. r. (dead); *Cyprina islandica*, r. (dead); *Pecten opercularis*, f.; *Pecten pusio*, v. r.; *Pecten maximus*, v. r.; *Pectunculus glycimeris*, v. r.; *Archidoris tuberculata*, one; *Archidoris johnstoni*, one; *Solen pellucidus* (valves), r.; *Portunus holsatus*, one; *Ebalia bryerii*, one; *Inachus dorsettensis*, f.; *Stenorhynchus rostratus*, f.; *Galathea dispersa*, one; *Galathea* sp. (?), f.; *Eupagurus prideauxii*, v. r.; *Eupagurus bernhardus*, f.; *Serpula vermicularis*, f.; *Serpula triquetra*, f.; *Nereis pelagica*, f.; *Polynöe*, sp. (?), f.; *Lanies conchilega*, one; *Aphrodite aculeata*, one; *Echinus esculentus*, f.; *Asterias rubens*, f.; *Solaster papposa*, one; *Henricia sanguinolenta*, f.; *Solaster endeca*, one; *Ophiothrix fragilis*, f.; *Ophiura albida*, one; *Flustra papyracea*, m. c.; *Flustra foliacea*, m. c.; *Flustra securifrons* (?) and several other Polyzoa, m. c.; *Adamsia palliata*, v. r.; *Hydractinia echinata*, m. c.; *Tubularia indivisa*, v. r.; *Tubularia coronata*, f.; *Lafoea dumosa*, f.; *Halecium halecinum*, f.; *Plumularia pinnata*, f.; *Halecinum plumosum* (?), f.; *Halecinum muricatum*, f.; *Antennularia antennina*, r.; *Hydrallmania falcata* (abdt.); *Sertularia abietina*, v. r.; *Sertularella tenella* (?), f.; *Campanularia verticillata* (?), abdt., and other Hydrozoa; sponge, sp. (?), a large branching specimen (*Halichondria*, sp. (?)); *Trichydra pudica* (?) (one colony on dead shell of *Cyprina islandica*).

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c. –I. MORAY FIRTH—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. **Station XV.** June 11. 1 hour 55 minutes.	*Fusus antiquus*, one ; *Stenorhynchus*, sp., one ; *Eupagurus bernhardus*, r. ; Ascidians, f. ; *Astropecten irregularis*, r. ; *Goniaster phrygianus*, one ; *Spatangus purpureus*, com. ; *Actinoloba dianthus*, r. ; zoophytes, f. ; sponge, one piece ; large Medusa, one.
Nov. 25. 2 hours.	*Ascidiella virginea* (?), abdt. ; *Ciona intestinalis*, one ; *Ascidia*, sp. (?), few. (The Ascidians were attached in great masses to the stems of Hydroids, dead shells, etc.) ; *Eledone cirrosa*, one ; *Fusus antiquus*, v. r. ; *Buccinum undatum*, f. (some with Eupagurids) ; *Fusus islandicus*, r. (with Eupagurids) ; *Natica alderi*, v. r. ; *Capulus hungaricus*, v. r. ; *Dentalium entale*, v. r. ; *Turritella terebra*, v. r. (with Eupagurids) ; several colonies of the eggs of *Buccinum undatum* ; *Cyprina islandica* (one living, dead valves), m. c. ; *Tellina incarnata*, one (several valves) ; *Cardium echinatum* (dead), m. c. ; *Pecten opercularis*, m. c. ; *Anomia ephippium*, f. ; *Petunculus glycimeris* (valves), r. ; *Portunus holsatus*, r. ; *Hyas coarctatus*, m. c. (young) ; *Inachus dorsettensis*, r. ; *Galathea dispersa*, v. r. ; *Galathea*, sp. (? *intermedia*), f. ; *Eupagurus prideauxii*, f. ; *Eupagurus bernhardus*, m. c. ; *Balanus hameri*, f. ; *Balanus balenoides*, r. ; *Saculina carcini* (on *Portunus holsatus*), one ; *Nereis pelagica*, v. r. ; *Polynöe cirrata*, f. ; *Polynöe*, sp. (?), v. r., and several other Annelids ; *Serpula triquetra*, f. ; *Serpula vermicularis*, m. c. ; *Flustra papyracea*, r. ; *Lepralia pallasiana*, f. ; *Lepralia pilosa*, f., and several other Polyzoa ; *Echinus esculentus*, f. ; *Spatangus purpureus*, one ; *Echinocardium cordatum* (one living and several dead tests) ; *Cucumaria frondosa*, one ; *Asterias rubens*, c. ; *Hippasterias phrygiana*, two ; *Henricia sanguinolenta*, one ; *Solaster papposa*, one ; *Ophiothrix fragilis*, r. ; *Adamsia palliata*, f. ; *Hydractinia echinata*, f. ; *Alcyonium digitatum*, abdt. ; *Hydrallmania falcata*, abdt. ; *Halecium halecinum*, v. r. ; *Halecium muricatum*, abdt. ; *Antennularia antennina*, one colony ; *Campanularia verticillata*, abdt., and several other Hydrozoa.
Station XVI. June 11. 1¾ hours.	*Buccinum* spawn, a small quantity ; *Eupagurus bernhardus*, r. ; *Eupagurus prideauxii*, r. ; *Eupagurus* (?) *cuanensis* (with accompanying sponge), r. ; Ascidians, f. ; *Asterias rubens*, fr. ; *Solaster endeca*, r. ; *Goniaster phrygianus*, fr. ; *Echinus esculentus*, fr. ; zoophytes (*Flustra*, &c.), f. ; sponge, r. ; *Alcyonium digitatum*, f.
	II. FIRTH OF CLYDE.
1897. **Station I.** April 5. 1⅝ hours.	*Pecten opercularis*, f. ; *Buccinum undatum*, one ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, f. ; *Porania pulvillus*, one ; *Echinus esculentus*, f. ; sea anemones, r.
May 25. 1½ hours.	*Pecten opercularis* f. ; *Buccinum undatum*, f. ; *Cyprina islandica*, one ; *Hyas coarctatus*, f. ; *Stenorhynchus*, sp., f. ; *Eupagurus prideauxii*, r. ; *Asterias rubens*, f. ; *Solaster endeca*, r. ; *Porania pulvillus*, f. ; *Spatangus purpureus*, f. ; *Echinus esculentus*, fr. ; spawn of *Buccinum*, a few large clusters ; a considerable quantity of weed.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—II. Firth of Clyde—*continued.*

Station and Date.	Organisms Captured.
1897. Sept. 14. 1 hour 5 minutes.	*Ascidia mentula*, f. ; *Ascidiella virginea*, r. ; *Trochus zizyphinus*, r. ; *Trochus umbilicatus*, f. ; *Trochus tumidus*, f. ; *Natica alderi*, r. ; *Natica montacuti*, r.; *Pecten opercularis*, ab.; *Eolidia*, sp., r.; *Anomia ephippium*, m. c. ; *Hyas coarctatus*, f. ; *Inachus dorynchus*, v. r. ; *Lithodes maia*, r.; *Eupagurus bernhardus*, m. c. ; *Eupagurus prideauxii*, f. (with *Adamsia palliata*) ; *Anapagurus lævis*, v. r. ; *Caridion gordoni*, r. ; *Hippolyte varians*, v. r.; *Pandalus annulicornis*, r. (young) ; *Pandulus*, sp., r. ; *Galathea intermedia*, r. ; *Eupagurus pubescens*, v. r. ; *Solaster papposa*, r. ; *Asterias rubens*, f. ; *Asterias glacialis*, one ; *Solaster endeca*, v. r. ; *Ophiothrix fragilis*, f. ; *Porania pulvillus*, f. ; *Echinus esculentus*, c. ; *Echinus miliaris*, f. ; *Sertularia abietina*, m. c. ; *Antennularia ramosa*, m. c. ; *Serpula triquetra*, f. ; *Serpula vermicularis*, r. ; *Lepralia foliacea*, r. ; *Lepralia*, sp., r. ; *Stematopora expansa*, f. ; *Suberites ficus*, r. ; sponge, sp., on *Pecten opercularis*, abdt. ; *Carinella annulata*, one.
Station II. April 3. 1½ hours.	*Pecten opercularis*, f. ; *Cyprina islandica*, one ; *Dosinia exoleta*, one ; *Gylophaga* (in pieces of old wood), fr. ; *Buccinum undatum* (junr.), one ; *Gibbula cineraria*, r. ; *Lithodes maia*, one ; *Eupagurus prideauxii*, f. ; Ascidians, r ; *Asterias rubens*, f. ; *Luidia ciliaris*, one ; *Porania pulvillus*, one, f. ; *Echinus esculentus*, fr. ; *Filograna implexa*, small pieces ; *Sabella*, sp., four (one with two specimens of the Copepod *Sabelliphilus Sarsi* adhering to it) ; zoophytes, f. ; sea-weed, a considerable quantity.
May 19. 1¾ hours.	*Pecten opercularis*, f. ; *Gibbula cineraria* ; *Buccinum undatum*, r. ; *Neptunea antiqua*, r. ; *Eupagurus prideauxii*, fr. ; *Asterias rubens*, fr. ; *Asterias glacialis*, one ; *Luidia ciliaris*, v. r. ; *Solaster endeca*, r. ; *Porania pulvillus*, r. ; *Echinus esculentus*, fr. ; sea anemones, f. ; sea-weed, a considerable quantity.
Sept. 14. 9.15 a.m. to 11 a.m.	*Ascidia mentula*, abdt. ; *Ascidia*, sp., f. ; *Trochus tumidus*, f. ; *Trochus magus*, one ; *T. milligranus*, f. ; *T. umbellicatus*, f. ; *T. zizyphinus*, f. ; *T. cinerarius*, r. ; *Buccinum undatum*, r. ; *Fusus gracilis*, v. r. ; *Fusus propinquus*, v. r. (dead) ; *Philine scabra*, v. r. ; *Chiton marmoreus*, v. r.; *Chiton ruber*, r. ; *Velutina lævigata*, r. ; *Cyprina islandica*, v. r. (dead) ; *Pecten opercularis*, r. ; *Pecten maximus*, v. r. ; *Modiolaria marmorata*, m. c. ; *Hyas coarctatus*, r. ; *Inachus dorynchus*, r. ; *Stenorhynchus rostratus*, v. r. ; *Cancer pagurus*, v. r. ; *Portunus depurator*, r. ; *Eupagurus bernhardus*, r.; *Galathea intermedia*, f.; *Nephrops norvegicus*, m. c. ; *Pandalus brevirostris*, r. ; *Scapellum vulgare*, v. r. ; *Balanus hameri*, f. ; *Eupagurus prideauxii*, abdt. ; *Balanus lævis*, r. ; *Hippolyte*, sp., r. ; *Echinus esculentus*, abdt. ; *Echinus miliaris*, f. ; *Asterias rubens*, f. ; *Asterias glacialis*, r. ; *Solaster papposa*, r. ; *Palmipes placenta*, v. r. ; *Luidia ciliaris*, m. c. ; *Ophiothrix fragilis*, f. ; *Serpula triquetra*, c. ; *Serpula vermicularis*, r. ; *Sabella pavonia*, r. ; *Sabella*, sp., r. ; *Eunice*, sp., r. ; *Nereis pelagica*, f. ; *Nereis*, sp., r. ; *Syllix tubifex*, r. ; *Hermione* sp., r.; *Polynöe*, sp. (?), r.; *Flustra papyracea*, m. c. (and other Polyzoa) ; *Antennularia ramosa*, r. ; *Hydrallmania falcuta*, f. (and a few other Hydrozoa) ; a great quantity of *Laminaria*, *Fucus*, and other sea-weed came up in the trawl-bag, with a few Amphipods attached.
Station III. April 2. $1\frac{4}{6}$ hours.	*Modiola modiolus*, r. ; *Saxicava rugosa*, one ; *Pecten opercularis*, one ; *Gibbula cineraria*, one ; *Zizyphinus miligranus*, one ; *Trivia europea*, one ; *Buccinum undatum* (junr.), f. ; *Ascidians*, f. ; *Stenorhynchus*, sp., r. ; *Hyas coarctatus*, fr. ; *Portunus depurator*, r. ; *Eupagurus bernhardus*, one ; *Galathea*, sp., one ; *Nephrops norvegicus*, fr. ; *Hippolyte pandaliformis*, v. r. ; *Porania pulvillus*, two ; *Echinus esculentus*, f. ; sea anemones, f. ; sea-weed, a considerable quantity, mixed up among which were some zoophytes.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—II. Firth of Clyde—*continued.*

Station and Date.	Organisms Captured.
1897. May 19. $1\frac{2}{6}$ hours.	*Hyas coarctatus,* f. ; *Lithodes maia,* one ; *Nephrops norvegicus,* f. ; *Echinus esculentus,* f. ; sea anemones, f. ; a quantity of weed.
Sept. 13. 4.45 p.m. to 6.10 p.m.	*Ascidia mentula,* f. ; *Ascidiella virginea,* r. (attached to *Tubularia indivisa*) ; *Isocardia cor.* r. (dead) ; *Loligo forbesi* (?), v. r. ; *Rossia macrosoma,* r. ; *Anomia ephippium,* m. c. ; *Anomia squamula* (?), r. ; *Pecten opercularis,* r. ; *Mytilus barbatus,* r. ; *Circe minima,* v. r. ; *Saxicava rugosa,* f. ; *Lacuna,* sp., v. r. ; *Eulima polita,* v. r. ; *Buccinum undatum,* r. (young) ; *Turritella terebra,* f. (dead). *Nephrops norvegicus,* abdt. ; *Portunus depurator,* v. r. ♀ ; *Inachus dorsettensis,* r. ; *Inachus dorynchus,* r. ; *Porania pulvillus,* f. ; *Luidia ciliaris,* v. r. ; *Asterias rubens,* f. ; *Solaster endeca,* f. ; *Ophiothrix fragilis,* f. (young) ; *Sabella pavonia,* r. ; *Pectinaria belgica,* v. r. ; *Actinia,* sp., abdt. ; *Stomphia churchiæ,* r. ; *Tubularia indivisa,* c. ; *Tubularia larynx,* m. c. ; *Sertularia abietina,* r. ; *Thuiaria articularia,* r. ; *Antennularia ramosa,* r., and other Hydroids ; *Hyperammina arborescens,* on pieces of coal, r. ; *Deudrophaga erecta,* on pieces of coal, v. r. ; *Planorbulina mediterranensis,* c., on pieces of coal, c. ; *Truncatulina lobatula,* on pieces of coal, r. ; *Discorbina rosacea,* on Hydroids, m. c.
Station IV. April 2. $\frac{4}{6}$ hour.	*Pecten opercularis,* f. ; *Rossia macrosoma,* one ; Ascidians, several ; *Inachus,* sp., one ; *Eupagurus prideauxii,* one ; *Lithodes maia,* one ; *Asterias rubens,* r. ; *Porania pulvillus,* one ; *Echinus esculentus,* fr. ; sea anemones, f.
May 19. $\frac{4}{6}$ hour.	*Pecten opercularis,* r. ; *Neptunea antiqua,* one ; *Sepiola rondeletii,* two ; *Hyas coarctatus,* r. ; *Eupagurus prideauxii,* f. ; *Stenorhynchus,* sp., r. ; *Lithodes maia,* one (jun.) ; *Nephrops norvegicus,* r. ; *Asterias rubens,* r. ; *Solaster papposa,* r. ; *Porania pulvillus,* r. ; *Palmipes placenta,* one ; *Brissopsis lyrifera,* one ; zoophytes and sponge, r. ; a small quantity of weed.
Sept. 13. 3.5 p.m. to 3.45 p.m.	*Ascidia depressa* (?), r. ; *Sepiola rondeletii,* v. r. ; *Loligo forbesi,* v. r. ; *Pecten opercularis,* abdt. (with sponge, sp. ?) ; *Cyprina islandica,* v. r. (dead) ; *Anomia ephippium,* f. ; *Anomia patelliformis,* r. ; *Pecten tigrinus,* v. r. ; *Mytilus barbatus,* r. ; *Tectura fulva,* r. ; *Lithodes maia,* m. c. ; *Cancer pagurus,* r. ; *Nephrops norvegicus,* f. ; *Portunus depurator,* v. r. ; *Inachus dorynchus,* r. ; *Anapagurus lævis,* v. r. ; *Amphipods,* few of several species ; *Asterias rubens,* f. ; *Parania pulvillus,* v. r. ; *Solaster endeca,* v. r. ; *Echinus esculentus,* f. ; *Ophiothrix fragilis,* f. (young) ; *Serpula vermicularis,* r. ; *Sabella bicoronata,* r. ; *Pectenaria belgica,* r. ; *Aphrodite aculeata,* v. r. ; *Hermione hystrix,* v. r. ; *Sabella,* sp., and a few other worms ; *Sertularia abietina,* r. ; *Sertularia argentea,* v. r. ; *Antennularia antennina,* r. ; *Aglophenia pluma,* v. r. ; *Hyperammina arborescens,* m. c., on clinkers ; a quantity of *Laminaria* came up in the trawl.
Station V. April 21. $1\frac{7}{12}$ hours.	*Pecten opercularis,* f. ; Ascidians, f. ; *Lithodes maia,* two ; *Eupagurus prideauxii,* f. ; *Nephrops norvegicus,* one ; *Asterias rubens,* r. ; *Stichaster roseus,* one ; *Porania pulvillus,* one ; sea anemones and hydroid zoophytes, r. ; *Cyprina islandica,* two.
May 20. $\frac{11}{12}$ hour.	*Schœurgus cirrhosa,* one ; *Pecten opercularis,* f. ; *Scaphander lignarius,* one ; Ascidians, f. ; *Hyas coarctatus,* one ; *Lithodes maia,* one ; *Eupagurus prideauxii,* f. ; *Asterias rubens,* f. ; *Astropecten irregularis,* one : *Filograna implexa,* f. ; sea anemone, one ; *Echinus esculentus,* c. ; a quantity of weed.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—II. FIRTH OF CLYDE—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. Sept. 24. 10.40 a.m. to 12.40 a.m.	*Ascidia mentula*, abdt. ; *Ascidiella virginea*, r. ; *Ascidia, sp.* (?), r. ; *Octopus vulgaris*, v. r. ; *Trochus umbilicatus*, f. ; *T. tumidus*, r. ; *T. millegranus*, f. ; *T. cinerarius*, r. ; *Emarginula rosea*, v. r. ; *Helcion pellucidum*, f. ; *Thracia*, sp., r. ; *Lutrania elliptica*, v. r. (dead) ; egg capsules of *Fucus antiquus*, m. c. (living, immature); *Mactra elliptica*, v. r. ; *Venus exoleta*, v. r. ; *Pecten opercularis*, abdt. ; *Linea hians* and nests, f., young (nest built of the dead fronds of *Laminaria*, etc.) ; *Cardium echinatum*, v. r. (dead) ; *Cardium fasciatum*, v. r. ; *Modiolaria marmorata*, c., in *Ascidia mentula* ; *Anomia ephippium*, c., on *P. opercularis* ; *Anomia patelliformis*, v. r. ; *Pecten tigrinus*, r. ; *Pecten*, sp. ; *Saxicava rugosa*, f. ; *Pecten pusio*, r. ; *Circe minima*, v. r. ; *Hyas coarctatus*, f. ; *Cancer pagurus*, three ♀ ; *Galathea dispersa*, f. ; *Pandulus annulicornis*, f. ; *Hippolyte securifrons*, v. r. ; *Eupagurus bernhardus*, r. ; *Eupagurus pubescens*, v. r. ; *Eupagurus prideauxii*, f. ; *Echinus esculentus*, abdt. ; *Echinus miliaris*, r. ; *Asterias rubens*, f. ; *Asterias glacialis*, v. r. ; *Solaster endeca*, r. ; *Solaster papposa*, r. ; *Porania pulvillus*, f. ; *Luidia ciliaris*, v. r. ; *Henricia sanguinolenta*, v. r. ; *Ophiopholis aculeata*, r. ; *Ophiocoma nigra*, v. r. (young) ; *Ophiothrix fragilis* (young), r. ; *Filigrana implexa*, f. ; *Sabella pavonia*, f. (young) ; *Sabella*, sp. (?), r. ; *Serpula triquetra*, m. c. ; *Serpula vermicularis*, c. ; *Serpula reversa*, v. r. ; *Terebella nebulosa* (?), r. ; *Sabellaria*, sp. (?), f. ; *Polynöe reticulata*, r. ; *Polynöe*, sp. (?), r. ; *Nereis pelagica*, f., and several other Annelids ; *Cellaria fistulosa*, f. ; *Membranipora membranacea*, f. ; *Lepralia foliacea*, f., and other Polyzoa ; *Adamsia palliata*, f. ; *Actinia*, sp. (?), f. ; *Sertularia abietina*, r. ; *Hydractinia echinata*, v. r. ; *Hydrallmania falcata*, r. ; *Antennularia antennina*, r.
Station VI.	
April 5. 2 hours.	*Pecten opercularis*, r. ; *Neptunea antiqua*, r. ; *Doris* (?) *johnstoni*, one ; *Hyas coarctatus*, one; *Eupagurus bernhardus*, r. ; *Eupagurus prideauxii* (with accompanying *Adamsia*), f. ; *Eupagurus cuanensis* (with enclosing sponge), f. ; *Asterias rubens*, f. ; *Parania pulvillus*, one ; *Echinus esculentus*, fr. ; *Alcyonium digitatum*, v. r. ; Hydroid zoophytes, f. ; Rhizostoma (large, with a number of *Hyperia* inside), one ; a small quantity of weed.
May 25. 1½ hours.	*Pecten opercularis*, f. ; *Stenorhynchus*, sp., f. ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, f. ; *Solaster papposa*, one ; *Solaster endeca*, one ; *Porania pulvillus*, f. ; *Spatangus purpureus*, fr. ; *Cucumaria*, sp., one ; *Aphrodite aculeata*, one ; sea anemones, r. ; some zoophytes and weed.
Sept. 15. 8.35 a.m. to 10.35 a.m.	*Ascidia*, sp., r. ; *Fusus gracilis*, r. (dead) ; *Buccinum undatum*, r. ; *Turritella terebra*, m. c. (with *Actinia*, sp. ?) ; *Pecten opercularis*, c. (with sponge) ; *Cancer pagurus*, two ♀ ; *Hyas coarctatus*, f. ; *Inachus dorynchus*, r. ; *Eupagurus bernhardus*, f. ; *Eupagurus prideauxii*, c. ; *Pandalus annulicornis* (young), f. ; *Pandalus brevirostris* (?), r. ; *Spatangus purpureus*, r. ; *Echinus esculentus*, m. c. ; *Asterias rubens*, f. (large, with ova) ; *Astropecten irregularis*, v. r. ; *Porania pulvillus*, f. ; *Ophiothrix fragilis*, f. (young) ; *Serpula triquetra*, m. c. ; *Sabella*, sp., r. ; *Flustra papyracea*, abdt. ; *Perella*, sp. (?), and several other Polyzoa. *Sertularia abietina*, r. ; *Antennularia ramosa*, m. c. ; *Campanularia flexuosa* (?) ; sponges, sp. (?), several, with a quantity of *Laminaria*, *Fucus*, and other weeds.
Station VII.	
Apr. 26-27. 1¾ hours. (Night haul.)	*Pecten opercularis*, r. ; *Stenorhynchus*, sp., r. ; *Nephrops norvegicus*, fr. ; *Asterias rubens*, f.
April 27. 1¾ hours.	*Pecten opercularis*, r. ; *Eupagurus prideauxii*, f. ; *Nephrops norvegicus*, c. ; *Asterias rubens*, r. ; *Asterias glacialis*, one ; *Astropecten irregularis*, one ; *Porania pulvillus*, r.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—II. Firth of Clyde—*continued.*

Station and Date.	Organisms Captured.
1897. May 17. 1¾ hours.	*Eupagurus prideauxii*, two ; *Nephrops norvegicus*, f. ; *Asterias rubens*, f. ; *Luidia ciliaris*, one ; *Brissopsis lyrifera*, f. ; *Aphrodite aculeata*, one.
May 21. 1⅚ hours.	*Pecten opercularis*, r. ; *Eupagurus bernhardus*, r. ; *Nephrops norvegicus*, fr. ; *Asterias rubens*, r. ; *Porania pulvillus*, r. ; *Aphrodite aculeata*, one.
Sept. 29. 11.5 a.m. to 1.43 p.m.	*Fusus antiquus*, r. ; *Fusus gracilis*, r. ; *Ascidia*, sp. (?), r. ; *Pecten opercularis*, m. c. ; *Anomia ephippium*, f. ; *Pecten tigrinus*, v. r. ; *Cardium fasciatum*, v. r. ; *Cardium nodosum*, v. r. ; *Cardium echinatum*, r. (dead) ; *Saxicava rugosa*, f. ; *Inachus dorynchus*, r. ; *Hyas coarctatus*, r. ; *Nephrops norvegicus*, f. ; *Crangon allmani*, f. ; *Eupagurus pubescens*, v. r. ; *Eupagurus prideauxii*, v. r. ; *Asterias rubens*, r. ; *Luidia ciliaris*, v. r. ; *Solaster endeca*, v. r. ; *Solaster papposa*, v. r. ; *Echinus esculentus*, f. ; *Spatangurus purpureus*, v. r. ; *Ophiothrix fragilis*, r. ; *Ophiura albida*, v. r. ; *Aphrodite aculeata*, v. r.. ; *Serpula triquetra*, r. ; *Serpula vermicularis*, f. ; *Stromphia churchiæ*, r. ; *Alcyonium digitatum*, m. c. ; *Tubularia indivisa*, f. ; *Adamsia palliata*.
Night Trawl. Sept. 29. 7.10 p.m. to 9.5 p.m.	*Cancer pagurus* (♀), three ; *Nephrops norvegicus*, abdt. ; *Eupagurus bernhardus*, v. r. ; *Eupagurus prideauxii*, v. r. ; *Balanus hameri*, f. ; *Brissopsis lyrifera*, f. ; *Asterias rubens*, r. ; *Asterias glacialis*, v. r. ; *Solaster papposa*, r. ; *Antennularia ramosa*, f. ; *Antennularia antennina*, r. ; *Aglophenia myriophyllum*, v. r. ; *Hydrallmania falcata*, r. ; *Sertularia pumila*, r. ; *Sertularia abietina*, f. ; *Sertularia argentea*, f. ; *Sertularia operculata*, v. r. ; *Thuiaria articulata*, v. r. ; *Virgularia mirabilis*, one ; *Pennatula phosphorea*, one ; *Sarcodictyon catenata* ; *Suberites demuncula*, one ; *Hyporammina arborescens*, f. (on fronds of Hydrozoa) ; *Astrorhiza limicola*, one ; *Textularia saggitula*, f. ; *Textularia agglutinans*, f. ; *Discorbina rosacea*, f., and *Truncatulina lobatula*, f., with *Planorbulina mediterranensis*, f., all living on Hydrozoa.
Station VIII. April 26. 1⅚ hours. (Night haul.)	*Nephrops norvegicus*, f. ; *Asterias rubens*, r. ; *Luidia ciliaris*, one ; *Brissopsis lyrifera*, c. ; *Aphrodite aculeata*, one ; a small quantity of sea-weed.
April 27. 1¾ hours.	*Neptunea antiqua*, one ; *Nephrops norvegicus*, c. ; *Brissopsis lyrifera*, several.
May 17. $1\frac{11}{12}$ hours.	*Nephrops norvegicus*, f. ; *Asterias rubens*, one ; *Palmipes placenta*, three ; *Echinus esculentus*, one ; *Brissopsis lyrifera*, r. ; *Aphrodite aculeata*, one ; a small quantity of weed.
May 20. 1⅚ hours.	*Nephrops norvegicus*, f. ; *Asterias rubens*, f. ; *Palmipes placenta*, one ; *Brissopsis lyrifera*, f. ; a small quantity of weed.

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

B. INVERTEBRATE FAUNA, &c.—II. Firth of Clyde—*continued.*

Station and Date.	Organisms Captured.
1897. Night Trawl. Sept. 29. 10.30p.m. to 12.20 a.m.	*Ascidia mentula*, r. ; *Polycarpa rustica*, v. r. ; *Ciona intestinalis* (?), v. r. ; *Turritella terebra*, v. r. (dead) ; *Micula sulcata*, f.; *Pecten opercularis*, r.; *Pecten tigrinus*, v. r. ; *Saxicava rugosa*, f. ; *Anomia ephippium*, f. ; *Leda minuta*, v. r. ; *Portunus depurator*, v. r. ; *Hyas coarctatus*, r. ; *Inachus dorynchus*, f. ; *Stenorhynchus rostratus*, f. ; *Cancer pagurus* (♀), three ; *Nephrops norvegicus*, c. ; *Pandalus annulicornis*, f. ; *Crangon allmani*, f. ; *Crangon spinosus*, r. ; *Crangon echinulatus*, v. r. ; *Galathea dispersa*, r. ; *Galathea intermedia*, v. r. ; *Eupagurus pubescens*, v. r. ; *Eupagurus bernhardus*, v. r. ; *Anapagurus lævis*, r. ; *Balanus hameri*, v. r. ; *Balanus lævis*, v. r. ; *Scapellum vulgare*, v. r. ; *Asterias rubens*, r.; *Luidia ciliaris*, v. r. ; *Palmipes placenta*, r. ; *Brissopsis lyrifera*, f. ; *Thyone raphanus*, v. r. ; *Amphiura chiajii*, v. r. ; *Amphiura filiformis*, r. ; *Aphrodite aculeata*, v. r. ; *Sabella pavonia*, r. ; *Hermione hystrix*, v. r. ; *Pectinaria belgica*, r. ; *Serpula triquetra*, v. r. ; *Serpula reversa* (?), r. ; *Echiurus* (?), sp. (?), v. r. ; *Sipinculus* (?), sp. (?), r. ; *Pennatula phosphorea*, m. c. ; *Sertularia abietina*, f. ; *Sertularia pumila*, r. ; *Antennularia ramosa*, c. ; *Antennularia antennina*, f. ; *Aglaophenia myriophyllum*, v. r. ; *Alcyonidium gelatinosum*, v. r.
Station IX. Apr. 22. $1\frac{5}{6}$ hours.	*Neptunea antiqua*, one ; *Nephrops norvegicus*, c. ; *Lepiophtheirus caudatus* (from thornback skate), ; a small quantity of weed.
May 17. $1\frac{5}{6}$ hours.	*Nephrops norvegicus*, f. ; *Palmipes placenta*, one ; *Aphrodite aculeata*, one ; *Pontobdella muricata*, one ; some zoophytes and sea-weed.
Sept. 28. 1.35 p.m. to 3.30 p.m.	*Sepiola rondelettii*, r. ; *Nephrops norvegicus* in great abundance ; *Hyas coarctatus*, f. ; *Inachus dorynchus*, r. ; *Echinus esculentus*, r. (young) ; *Asterias rubens*, r. ; *Luidia ciliaris*, v. r. ; *Antennularia ramosa*, m. c.; *Sertularia argentea.*
Station X. April 28 $1\frac{5}{6}$ hours.	*Tritonia hombergi*, one ; *Hyas coarctatus*, one ; *Eupagurus prideauxii*, one ; *Nephrops norvegicus*, f. ; *Asterias rubens*, several ; *Porania pulvillus*, two ; *Echinus esculentus*, f. ; some sea-weed.
May 22. $1\frac{5}{6}$ hours.	*Cyprina islandica*, one ; *Eupagurus bernhardus*, r. ; *Asterias rubens*, f. ; *Asterias glacialis*, r. ; *Echinus esculentus*, r. ; *Porania pulvillus*, f. ; sea anemones, r.
Sept. 15. 11.55 a.m. to 1.45 p.m.	*Ascidia mentula*, r. ; *Ascidia depressa*, v. r. ; *Eledone cirrosa*, one ; *Fusus propinquus*, v. r. ; *Turritella terebra*, c. (with *Actinia*, sp. ?) ; *Fusus gracilis*, v. r. (dead, with Pagurids) ; *Lucina borealis*, v. r. ; *Gonoplax angulata*, one ; *Portunus depurator*, f. ; *Inachus dorynchus*, f. ; *Stenorhynchus longirostris*, r. ; *Nephrops norvegicus*, c.; *Eupagurus prideauxii*, c. ; *Eupagurus cuanensis*, v. r. ; *Galathea dispersa*, r. ; *Stenorhynchus rostratus*, r.; *Balanus hameri*, f.; *Solaster papposa*, f. ; *Asterias rubens*, f. (with ova) ; *Echinus esculentus*, f.; *Ophiura ciliaris*, r. ; *Ophiothrix fragilis*, f. (young) ; *Adamsia palliata*, c. ; *Pennatula phosphorea*, r. ; *Alcyonium digitatum*, r.; *Antennularia ramosa*, c. ; *Halecium halecinum*, f. ; *Sertularia pumila*, r. ; *S. abietina*, f.; *S. argentea*, v. r. ; *Hydrallmania falcata*, f.; *Antennularia antennina*, f.; *Aglaophenia pluma*, v. r.; *Plumularia pinnata* (?), r. ; *Lepralia foliacea*, r. ; *Cellepora pumicosa*, r.; *Cellepora ramulosa*, v. r. ; *Cellepora armata*, v. r. ; *Porella compressa*, r., and other Polyzoa.
Station XI. April 21. $1\frac{3}{4}$ hours.	*Botryllus* spawn, r. ; *Nephrops norvegicus*, abdt. ; *Asterias glacialis*, one ; *Porania pulvillus*, r.; *Echinus esculentus*, r.; *Brissopsis lyrifera*, several; a quantity of sea-weed.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—II. FIRTH OF CLYDE—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. May 20. $1\frac{3}{4}$ hours.	*Neptunea antiqua*, one ; *Nephrops norvegicus*, f. ; *Asterias rubens*, f. ; *Solaster papposa*, one ; *Porania pulvillus*, r. ; *Echinus esculentus*, f. ; *Brissopsis lyrifera*, r. ; a considerable quantity of weed.
Sept. 27. 10.30 a.m. to 12.25 p.m.	*Ascidia mentula*, v. r. ; *Ascidia*, sp (?), r. ; *Octopus vulgaris*, v. r. ; *Fusus antiquus*, v. r. ; *Natica montagui*, r. (dead, with Pagurid and Hydractinia) ; *Anomia ephippium*, m. c. ; *Echinus esculentus*, v. r. ; *Asterias rubens*, f. ; *Porania pulvillus*, r. ; *Ophiothrix fragilis*, f. ; *Galathea dispersa*, r. ; *Filigrana implexa* ; *Serpula vermicularis*, f. A considerable quantity of *Laminaria*, *Fucus*, and other sea-weeds came up in the trawl, also an old pail covered more or less with *Anomia ephippium*, *Serpula vermicularis*, and a few young *Ophiothrix fragilis.*
Station XII. April 21. $2\frac{1}{12}$ hours.	*Nephrops norvegicus*, abdt.
April 28. 2 hours. (Night haul.)	*Portunus depurator*, one ; *Nephrops norvegicus*, abdt. ; *Asterias rubens*, r. ; *Brissopsis lyrifera*, f. ; *Rhizostoma*, sp., one ; *Aglaophenia*, sp., v. r. ; a small quantity of sea-weed.
May 20. 2 hours.	*Nephrops norvegicus*, fr. ; *Galathea*, sp., f. ; *Sepiola rondeletii*, f. ; *Asterias rubens*, f. ; *Brissopsis lyrifera*, f. ; zoophytes, f. ; a small quantity of sea-weed.
May 26. 2 hours. (Night haul.)	*Munida rugosa*, one ; *Nephrops norvegicus*, abdt. ; *Brissopsis lyrifera*, v. r. ; zoophytes and weed, f.
Sept. 24. 1.55 p.m. to 3.55 p.m.	*Rossia macrosoma*, r. ; *Eledone cirrosa*, v. r. ; *Cyprina islandica*, f. (living) ; *Isocardia cor.*, one (living) ; *Natica montagui*, r. ; *Nucula sulcata*, f. ; *Nephrops norvegicus*, very abdt. ; *Portunus depurator*, r. ; *Pandalus annulicornis*, f. ; *Crangon allmania*, f. ; *Galathea dispersa*, f. ; *Stenorhynchus rostratus*, r. ; *Eupagurus prideauxii*, r. ; *Eupagurus pubescens*, v. r. ; *Anapagurus lævis*, v. r. ; *Brissopsis lyrifera*, f. ; *Sabella*, sp. (?), v. r. ; *Aglaophenia myriophyllum*, r. ; *Pennatula phosphorea*, v. r. ; *Adamsia palliata*, r. ; a little sea-weed and a quantity of grey mud came up in this trawl.
Night Trawl. Sept. 27. 9.30 p.m. to 11.30 p.m.	Little beside the fish came up in the trawl—a small quantity of mud and the following animals :—*Rossia macrosoma*, two ; *Fusus antiquus*, one (young) ; *Nephrops norvegicus*, f. ; *Brissopsis lyrifera*, f., and *Pennatula phosphorea*, few.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—III. CLYDE (LOCH FYNE).

Station and Date.	ORGANISMS CAPTURED.
1897. **Station XIII.** March 30. $1\frac{1}{12}$ hours.	*Pecten opercularis*, f. ; *Modiola modiolus*, one ; *Gibbula cineraria*, f. ; spawn of *Buccinum undatum*, one cluster ; Ascidians, f. ; *Hyas araneus*, f. ; *Hyas coarctatus*, one ; *Galathea*, sp., f. ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, fr. ; *Solaster papposa*, f. ; *Ophiocoma nigra*, f. ; *Echinus esculentus*, f.
May 27. $1\frac{1}{12}$ hours.	*Pecten opercularis*, fr. ; *Pecten striatus*, one ; *Zizyphinus millegranus*, f. ; *Gibbula cineraria*, f. ; *Tectura virginea*, v. r. ; *Hyas araneus*, f. ; *Eupagurus bernhardus*, one ; *Eupagurus prideauxii*, f. ; *Galathea squamifera*, v. r. ; *Asterias rubens*, f. ; *Ophiura texturata*, fr. ; *Ophiocoma nigra*, f. ; *Solaster papposa*, f. ; *Echinus esculentus*, fr. ; sea anemones, f. ; some sea-weed.
Oct. 11. 11.10 a.m. to 12.20 p.m.	*Ascidia mentula*, f. ; *Ascidiella virginea*, v. r. ; *Ciona intestinalis*, r. ; *Styelopsis grossularis*, v. r. ; *Fusus antiquus*, v. r. ; *Sipho* (*Fusus*) *gracilis*, v. r. ; *Aporrhias pes-pelicani*, r. ; *Gibbula* (*Trochus*) *tumida*, r. ; *Zizyphinus* (*Trochus*) *milligranus*, f. ; *Gibbula* (*Trochus*) *umbilicata*, f. ; *Zizyphinus* (*Trochus*) *zizyphinus*, c. ; *Pecten opercularis*, abdt. (and young on fronds of *Laminaria*); *Pecten tigrinus*, v. r. ; *Cyprina islandica* (dead shells), v. r. ; *Modiolaria discors*, c. (on roots of *Laminaria*) ; *Cancer pagurus*, two (♂ and ♀) ; *Hyas araneus*, f. ; *Hyas coarctatus*, v. r. ; *Portunus puber*, v. r. ; *Inachus dorsettensis*, v. r. ; *Nephrops norvegicus*, v. r. ; *Galathea dispersa*, f. ; *Galathea intermedia*, v. r. ; *Pandalus brevirostris*, f. ; *Pandalus annulicornis*, r. ; *Spirontocanis* (*Hippolyte*) *securifrons*, v. r. ; *Eupagurus prideauxii*, f. ; *Eupagurus pubescens*, r. ; *Eupagurus bernhardus*, v. r. ; *Echinus esculentus*, abdt. (young); *Echinus miliaris*, f. ; *Asterias rubens*, c. ; *Solaster papposa*, v. r. ; *Ophiothrix fragilis*, abdt. and fine ; *Ophiocoma nigra*, f. ; *Henricia sanguinolenta* (?), v. r. ; *Stomphia churchiæ*, v. r. ; *Bolocera tuediæ*, f. ; *Adamsia palliata*, f ; *Suberites domuncula*, r. ; sponge, sp. ? (on *Pecten opercularis*), m. c. ; *Nucula tenuis*, one ; *Pelosina variabilis*, f.
Station XIV. March 30. $1\frac{2}{6}$ hours.	*Pecten opercularis*, f. ; *Gibbula cineraria*, f. ; *Buccinum undatum*, one ; *Hyas coarctatus*, r. ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, one ; *Ophiura texturata*, f. ; *Ophiocoma nigra*, f. ; *Ophiopholis aculeata*, f. ; *Solaster papposa*, one ; *Echinus esculentus*, f. ; *Alcyonium digitatum*, f. ; sea anemones, f.
May 27. $1\frac{2}{6}$ hours.	*Pecten opercularis*, f. ; *Sepiola rondeletii*, r. ; *Eupagurus prideauxii*, f. ; *Asterias rubens*, f. ; *Ophiura texturata*, f. ; *Ophiocoma nigra*, f. ; *Solaster papposa*, f. ; *Echinus esculentus*, f. ; sea anemones, f. ; a quantity of sea-weed.
Oct. 11. 2.45 p.m. to 3.55 p.m.	*Rossia macrosoma*, one ; *Fusus antiquus*, v. r. ; *Buccinum undatum*, r. ; *Trochus milligranus*, f. ; *Trochus ziziphinus*, f. ; *Trochus tumidus*, r. ; *Fusus islandicus*, v. r. ; *Lucuna puteolus*, v. r. ; *Littorina litorea*, r. (dead, with Pagurids) ; *Trochus umbilicata*, m. c. (on *Laminaria* fronds) ; *Velutina lævigata*, f. ; *Trichotropis borealis*, v. r. ; *Trophon truncatus*, v. r. ; *Pecten opercularis*, c. ; *Cyprina islandica* (dead valves), r. ; *Saxicava rugosa*, r. ; *Modiolaria discors*, f. (at the roots of Laminaria) ; *Cancer pagurus*, *three* ♀ (?) ; *Pandulus annulicornis*, r. ; *Pandulus brevirostris* (?), f. ; *Echinus esculentus*, abdt. (young) ; *Asterias rubens*, f. ; *Ophiothrix fragilis*, m. c. ; *Ophiocoma nigra*, r. ; *Balanus hameri*, m. c. (on *P. opercularis*) ; *Serpula triquetra*, m. c. ; *Serpula vermicularis*, m. c. ; *Filigrana implexa*, r. ; *Sabella*, sp. (?) r. ; *Neomenia carinata*, v. r. ; *Hyalinæcea tubicola*, v. r. ; *Nereis pelagica*, f. (at roots of *Laminaria*) ; *Chætopterus variopedatus*, v. r. (in valves of *Cyprina islandica*) ; sponge, sp. (?), (on *P. opercularis*), m. c. ; *Ophiura ciliaris*, f.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

B. INVERTEBRATE FAUNA, &c.—III. CLYDE (LOCH FYNE)—*continued.*

Station and Date.	ORGANISMS CAPTURED.
1897. **Station XV.**	
March 30. $1\frac{7}{12}$ hours.	*Pecten opercularis*, f. ; *Velutina lævigata*, one ; *Gibbula cineraria*, f. ; *Eupagurus prideauxii*, f. ; *Eupagurus bernhardus*, one ; *Lithodes maia*, two ; *Bolocera tuediæ*, f. ; *Asterias rubens, one.*
May 27. $1\frac{5}{12}$ hours.	*Pecten opercularis*, f. ; *Pecten striatus*, one ; *Eupagurus prideauxii*, f. ; *Ophiura texturata*, f. ; *Ophiocoma nigra*, f. ; *Echinus esculentus*, f. ; *Bolocera tuediæ*, f. ; a small quantity of weed.
Oct. 8. 2.5 p.m. to 3.30 p.m.	Eggs of *Rossia macrosoma* ; *Archidoris johnstoni*, v. r. ; *Fusus antiquus*, r. (dead) ; *Buccinum undatum*, v. r. (dead) ; *Trochus milligranus*, f. ; *Trochus zizyphinus*, r. ; *Cardium echinatum*, r. (dead) ; *Pecten septem-radiatus*, r. ; *Pecten opercularis*, f. (young) ; *Lithodes maia*, f. ♀ (with nearly ripe eggs) ; *Carcinus mænas*, r. (with *Sacculina carcina*) ; *Nephrops norvegicus*, r. ; *Galathea dispersa*, r. ; *Eupagurus prideauxii*, f. ; *Eupagurus bernhardus*, v. r. ; *Echinus esculentus*, f. (young) ; *Echinus miliaris*, v. r. ; *Asterias rubens*, f. ; *Aphrodite aculeata*, v. r. ; *Serpula triquetra*, f. ; *Serpula vermicularis*, f. ; *Sabella*, sp. (?), r. ; *Polynöe*, sp. (?), r. ; and other Annelids ; *Bolocera tuediæ*, f. ; *Adamsia palliata*, f. ; *Stomphia churchiæ*, f. ; *Sertularella rugosa*, c. (on *Laminaria* fronds) ; *Suberites ficus*, r. ; sponges, sp. (?), f. ; *Galathea nexa* ; *Cancer pagurus*, one ♀ ; *Inachus dorsettensis* ; *Corbula gibba*, one ; *Solaster papposa.*
Station XVI.	
March 29. $2\frac{1}{4}$ hours.	*Pecten pes-lutræ*, f. (living, few, but a number of dead shells having one or both valves more or less covered with sponge) ; *Echinus esculentus*, one ; *Brissopsis lyrifera*, one.
May 28. $2\frac{2}{6}$ hours.	*Hyas araneus*, one ; *Lithodes maia*, one ; *Echinus esculentus*, f. ; *Bolocera tuediæ*, abdt.
Oct. 8. 10.35 a.m. to 12.40 p.m.	*Ascidiella scabra*, r. ; *Styelopsis grossularia*, m. c. (on *Pecten septem-radiatus*) ; *Polycarpa rustica*, f. ; *Fusus antiquus*, v. r. ; *Pecten septem-radiatus*, m. c. ; *Asterias rubens*, v. r. ; *Asterias murrayi* (?), v. r. ; *Brissopsis lyrifera*, var. (?), f. ; *Chætopterus variopedatus*, v. r. ; one tube of the large *Cirranthus*, sp. (?) ; *Bolocera tuediæ*, abdt. ; *Sabella pavonia*, r. ; *Sabella*, sp. (?), r. ; sponges, several species (?) ; *Panthalis œrstidi* (?), f. ; *Amphiura filiformis*, f.
Station XVII.	
March 29. $1\frac{1}{2}$ hours.	*Pecten striatus*, v. r. ; *Gibbula cineraria*, f. ; Ascidians, f. ; *Galathea*, sp., fr. ; *Asterias rubens*, one ; *Ophiura texturata*, f. ; *Amphiura*, sp., one ; *Echinus esculentus*, one ; *Aphrodite aculeata*, one ; Annelides, two ; a large quantity of sea-weed.
May 28. $1\frac{4}{6}$ hours.	Trawl-net filled with mud and sea-weeds.
Oct. 6. 9.10 a.m. to 10.40 a.m.	*Ascidia mentula*, r. ; *Ascidiella scabra*, f. ; *Ascidiella virginea*, r. ; *Polycarpa rustica*, v. r. ; *Buccinum undatum*, f. ; *Trochus umbilicata*, f. ; *Trochus milligranus*, f. ; *Tarnatina umbilicata*, v. r. ; *Philine catena*, v. r. ; *Pecten tigrinus*, v. r. ; *Pecten opercularis*, f. ; *Saxicava rugosa*, r. ; *Pecten septem-radiatus*, v. r. ; *Cancer pagurus*, one ♀ ; *Hyas coarctatus*, f. ; *Hyas araneus*, v. r. ; *Pandalus brevirostris*, r. ; *Pandalus annulicornis*, f. ; *Caridion gordoni*, v. r. ; *Crangon allmani*, v. r. ; *Asterias rubens*, f. ; *Solaster papposa*, v. r. ; *Ophiothrix fragilis*, f. ; *Ophiura ciliaris*, v. r. ; *Ophiura albida*, v. r. ; *Amphiura filiformis*, r. ; *Echinus esculentus*, r. ; *Echinus miliaris*, v. r. ; *Brissopsis lyrifera*, r. ; *Serpula triquetra*, f. ; *Serpula vermicularis*, r. ; *Serpula reversa*, f. ; *Sertularella rugosa* (on *Laminaria* fronds) ; *Lofœa fruticosa*, r. ; *Eudendrium rameum*, v. r. ; *Hydractinia echinata*, v. r. ; *Crania anomala*, abdt. ; *Terebratula caput-serpentis*, f. ; *Fusus antiquus* ; *Cyprina islandica*, r. (young) ; *Corbula gibba*, v. r. ; *Anomia ephippium* ; *Pecten*, sp. (?), one ; *Sarcodictyon catenata*, var., abdt. over stones.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

C. PHYSICAL OBSERVATIONS—I. MORAY FIRTH.

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station I.												
1897.												
June 9.												
12.5 p.m.	E.	50·0	48·8	47·2	8½	S.S.E.	2	Cloudy.	Slight.	5¾ h. ebb.	29·92	5½
1.55 p.m.	W.	53·4	50·7	47·6	17	N. by W.	3	,,	,,	1½ h. fl.	,,	5¼
Nov. 8.												
10.5 a.m.	W.	50·90	51·2	51·0	9	S.E.	6	Dull and cloudy.	Rough.	5 ,,	30·12	5½
12.20 p.m.	E.	51·80	51·4	51·1	9¼	S.E.	5	Cloudy.	,,	1.10m.ebb.	30·14	6
Station II.												
June 9.												
2.47 p.m.	E.	53·6	52·3	46·3	19	S.S.W.	2	Cloudy.	Slight.	2¼ h. fl.	29·91	7
4.47 p.m.	W.	56·8	52·3	47·0	17	S.S.E.	2	,,	,,	4½ ,,	29·92	10
Nov. 5.												
11.45 a.m.	W.	44·96	49·9	51·1	14	W. by S.	2	Hazy.	Slight S.E. swell.	2½ h. ebb.	30·32	5½
2.10 p.m.	E.	46·04	49·7	51·3	17	W.	2	,,	Slight E. swell.	4¾ ,,	30·32	5
Station III.												
June 14.												
11.45 a.m.	W.	55·4	54·6	51·7	8½	N.W.	Light	Dull, with rain.	Smooth.	½ h. ebb.	29·89	3
12.55 p.m.	E.	55·4	52·3	51·2	19	N.	1	Dull.	Slight.	1¾ ,,	29·89	6
Nov. 6.												
9.10 a.m.	E.	45·68	50·4	50·0	8½	Calm.	0	Overcast.	Smooth.	5¼ h. fl.	30·44	5
10.35 a.m.	W.	46·22	49·0	49·6	7½	W. by S.	1	Overcast.	,,	½ h. ebb.	30·44	3½
Station IV.												
June 15.												
6.50 a.m.	E.	49·6	52·9	49·7	12¾	W.N.W.	4	Cloudy.	Moderate.	1 h. fl.	29·99	7
8.55 a.m.	W.	51·9	53·5	50·0	9½	W.	4	,,	,,	3 ,,	,,	7
Nov. 11.												
9.15 a.m.	E.	49·10	50·0	50·1	13	N by E.	1	Overcast.	E. swell.	3 ,,	30·8	5
11.35 a.m.	W.	49·28	49·0	50·0	8	Calm.	0	Overcast, passing showers.	Heavy E. swell.	4¼ ,,	30·6	4½
Station V.												
June 15.												
9.25 a.m.	S.W.	51·8	53·7	49·9	11¼	W.	4	Cloudy.	Moderate.	3½ h. fl.	29·99	7¼
11.10 a.m.	N.E.	53·0	51·8	47·7	18½	N.W.	4	,,	,,	5¼ ,,	29·98	7½
Nov. 11.												
11.55 a.m.	S.W.	50·00	50·1	49·9	13	S.	Light	Overcast, with rain.	Heavy E. swell.	5½ ,,	30·6	5½
2.5 p.m.	E.	51·44	50·2	50·1	20	E.	1	Cloudy.	Slight.	1¾ h. ebb.	30·0	7
Station VI.												
June 15.												
12.35 p.m.	W.	53·6	53·4	51·8	9	N.W.	4	Cloudy.	Moderate.	½ h. ebb.	29·97	7
2.20 p.m.	E.	59·0	52·6	48·5	19	,,	1	,,	Slight.	2¼ ,,	29·98	7
Nov. 10.												
9.7 a.m.	E.	51·98	49·8	49·9	18	S.	0	Cloudy.	Heavy E. swell.	3 h. fl.	30·16	5
10.45 a.m.	W.	50·00	50·1	50·0	12	S.	0	,,	,,	4h. 38m. fl.	,,	5

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

C. PHYSICAL OBSERVATIONS.—I. Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air.	Temperature. Water.			Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station VII. 1897.												
June 10.												
5.20 p.m.	E.	55·4	52·2	45·3	34	E.S.E.	2	Slight haze.	Slight.	3¼ h. fl.	30·07	7
7.20 p.m.	W.	55·0	51·9	45·3	31½	S.E.	2	Hazy.	,,	5¾ ,,	30·05	10
Nov. 10.												
12.0 a.m.	W.	51·80	50·5	50·3	25	S.S.W.	1	Cloudy.	Heavy E. swell.	Near high water.	30·16	9
2.10 p.m.	E.	52·88	51·3	50·8	34	S.S.E.	3	,,	Moderate.	1½ h. ebb.	30·10	10
Station VIII.												
June 10.												
2.36 p.m.	S.	57·7	52·4	45·3	33	S.E.	2	Hazy.	Slight.	1 h. fl.	30·07	11
4.30 p.m.	N.	56·3	51·9	45·6	26½	E.S.E.	2	Slight haze.	,,	3 ,,	,,	9
Nov. 9.												
12.30 a.m.	S.	52·70	50·9	51·0	34	S.E.	2	Clear.	E. swell.	1½ h. fl.	30·26	10½
3.0 p.m.	N.	52·70	51·2	51·0	34	S.E.	2	Cloudy.	E. swell.	3 h. ebb.	30·26	10
Station IX.												
June 10.												
10.50 a.m.	S.	57·0	51·5	45·5	34	Calm.	..	Hazy.	Slight E. swell.	3½ h. ebb.	30·05	11½
12.42 p.m.	N.	57·7	51·6	45·5	29½	E.S.E.	1	Slight haze.	Slight.	5½ ,,	30·07	8¼
Nov. 9.												
8.50 a.m.	N.	50·54	51·0	51·0	30½	S.S.E.	2	Hazy.	Choppy.	2 h. fl.	30·23	10
12.7 p.m.	S.	52·70	51·3	51·0	35	S.E.	2	Clear.	Choppy.	High water.	30·25	10½
Station X.												
June 10.												
7.31 a.m.	S.E.	52·7	49·2	45·3	34½	W.S.W.	2	Slight haze.	Slight E. swell.	¼ h. ebb.	30·01	7
9.25 a.m.	N.W.	55·5	50·1	44·9	34	Calm.	..	,,	,,	2¼ ,,	30·05	12
Nov. 8.												
1.30 p.m.	W.	49·64	51·0	50·8	35	S.E.	7	Overcast.	Heavy sea.	2h.10m.eb.	30·16	7
3.25 p.m.	S.E.	49·64	51·0	51·0	30	S.E.	6	,,	Heavy seas.	4 h. ebb.	30·18	7½
Station XI.												
June 11.												
3.20 a.m.	W.	50·7	49·2	46·3	23	S.	3	Dull, with rain.	Moderate.	1½ h. fl.	30·04	7
5.20 a.m.	E.	50·3	48·9	46·8	24½	..	..	Cloudy.	,,	3½ ,,	30·03	7½
Nov. 22.												
1.0 p.m.	W.	50·90	50·2	49·9	24	W. by S.	5	,,	,,	4h.25m.eb.	30·34	9
3.20 p.m.	E.	51·44	50·2	50·0	24	W. by S.	5	,,	,,	40 m. fl.	30·32	9
Station XII.												
June 11.												
6.5 a.m.	N.	50·9	48·9	46·8	25	S.	3	Cloudy.	Moderate.	4 h. fl.	30·01	7¼
7.55 a.m.	S.	52·1	48·9	46·3	24½	S.S.W.	3	Dull, with rain.	,,	5¾ ,,	30·03	7½
Nov. 22.												
9.45 a.m.	N.	51·80	50·2	49·8	23½	W. by S.	4	Cloudy.	,,	25 m. ebb.	30·37	10
12.0 a.m.	E.	51·80	50·1	49·9	22½	W. bv S.	5	,,	,,	3h. 25m. fl.	30·36	7

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

C. PHYSICAL OBSERVATIONS—I. Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station XIII.												
1897. June 11.												
12.25 p.m.	S.	57·5	49·7	46·3	30	S.E. by S.	1	Cloudy.	Slight.	4¼ h. ebb.	30·04	9½
1.50 p.m.	N.	58·6	49·7	46·5	26	,,	,,	,,	Slight S.E. swell.	5¾ ,,	30·04	8
Nov. 20.												
9.55 a.m.	S.	51·44	50·3	50·0	27½	W.S.W.	3	Overcast.	Moderate.	2¼ h. ebb.	30·34	10½
12.15 p.m.	N.	52·52	50·6	50·1	29½	W.	4	Cloudy.	,,	4¼ ,,	30·36	10
Station XIV.												
June 11.												
3.20 p.m.	S.	60·8	50·5	46·1	36	N.N.E.	Light.	Slight haze.	Slight S.E. swell.	1 h. fl.	30·03	7
5.15 p.m.	N.	55·9	50·5	46·1	40½	S.S.E.	1	Dull.	,,	3 ,,	30·03	7
Nov. 18.												
8.35 a.m.	N.	46·04	49·6	50·1	29	W. by S.	5	Clear.	Choppy.	3 h. ebb.	29·72	10
10.45 a.m.	S.	49·64	50·4	50·0	35	W.S.W.	6	Cloudy.	,,	5 ,,	29·80	10
Station XV.												
June 11.												
6.35 p.m.	N.	55·0	50·6	46·2	34	S.W.	2	Dull.	Slight S.E. swell.	4¼ h. fl.	30·02	7
8.30 p.m.	S.	54·8	51·4	45·5	35	S.	2	Cloudy.	Slight.	h. w.	29.99	7
Nov. 25.												
1.15 p.m.	N.	53·78	49·8	49·2	33¾	S.	5	,,	Moderate.	1¼ h. ebb.	30·32	8½
3.35 p.m.	S.	46·04	49·9	49·3	26½	S.	4	,,	,,	3¾ ,,	30·30	9
Station XVI.												
June 11.												
8.48 a.m.	N.	52·5	49·0	46·1	34	S. by W.	2	Dull.	Slight.	¾ h. ebb.	30·03	10
10.35 a.m.	S.	56·6	49·9	45·7	40¼	S. by E.	1	Cloudy.	,,	2½ ,,	30·04	9

II. Firth of Clyde.

Station, Date, and Hour.	End of Station.	Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I.												
April 5.												
6.35 a.m.	N.	39·92	43·0	43·6	21½	S.E.	4	Cloudy.	Slight.	4½ h. ebb.	30·02	5
8.5 a.m.	S.	41·0	43·1	43·4	22¼	,,	4	,,	,,	l. w.	30·02	5
May 25.												
10.35 a.m.	N.	49·46	49·0	46·2	21½	N.W.	4	Overcast.	,,	3¾ h. ebb.	29·76	6
12.5 p.m.	S.	51·44	49·0	46·8	20½	,,	2	,,	,,	5¼ ,,	29·76	5½
Sept. 14.												
12.40 a.m.	N.	58·82	54·8	51·5	25½	N.W.	1	,,	Smooth.	4½ h. fl.	30·50	8
2.10 p.m.	S.	59·00	55·0	53·2	13½	,,	1	Cloudy.	,,	Near h. w.	30·48	8
Station II.												
April 3.												
7.35 a.m.	Outer.	37·04	43·0	43·8	25	S.E.	6	Slight haze.	Choppy.	1 h. fl.	29·59	5
9.15 a.m.	Inner.	38·84	42·9	43·6	25	,,	6	,,	,,	2¾ ,,	29·56	4
May 19.												
7.35 a.m.	Outer.	44·24	47·0	46·3	23	E.	5	,,	Moderate.	About l. w.	30·28	7
9.20 a.m.	Inner.	50·72	46·8	46·0	22½	S.E.	2	,,	Slight.	1¾ h. fl.	30·28	7½

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

C. PHYSICAL OBSERVATIONS—II. Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
1897. Sept. 14.												
9.15 a.m.	Outer.	59·90	55·3	52·6	22	N.N.W.	Light	Hazy.	Smooth.	1½ h. fl.	30·50	9½
11.0 a.m.	Inner.	60·62	55·9	52·8	17½	N.W.	1	Overcast.	,,	2¾ ,,	30·50	9
Station III.												
April 2.												
5.5 p.m.	N.	40·10	43·9	43·5	25	S.S.W.	2	Cloudy.	Slight.	4¾ h. ebb.	29·74	5½
6.45 p.m.	S.	39·56	44·0	43·7	34	S.	Light	,,	Smooth.	½ h. fl.	29·74	6
May 19.												
10.20 a.m.	S.	48·56	46·7	44·7	31	N.E.	5	Slight haze.	Moderate.	2¾ h. fl.	30·26	7½
11.40 a.m.	N.	50·90	46·2	45·0	45	,,	4	,,	,,	4 ,,	30·24	7
Sept. 13.												
4.45 p.m.	N.	61·34	55·7	52·4	22	S.S.W.	1	Fine.	Smooth.	3½ h. ebb.	30·50	7½
6.10 p.m.	S.	61·88	56·2	50·9	35½	S.	Light airs.	,,	,,	4¾ ,,	30·50	7¼
Station IV.												
April 2.												
3.30 p.m.	N.	47·48	44·1	43·6	30	N.N.W.	1	Cloudy.	Smooth.	3¼ h. ebb.	29·74	6
4.10 p.m.	S.	41·54	44·1	43·5	19	S.S.W.	3	,,	Slight.	3¾ ,,	29·73	7
May 19.												
1.5 p.m.	S.	55·22	48·0	45·5	31	Variable	Light	Slight haze.	,,	5¼ h. fl.	30·23	6½
1.45 p.m.	N.	54·68	47·3	45·0	41½	N.E.	3	,,	,,	h. w.	30·22	7
Sept. 13.												
3.5 p.m.	N.E.	67·82	55·4	51·4	28	,,	1	Fine.	Smooth.	1¾ h. ebb.	30·49	8
3.45 p.m.	S.W.	67·46	55·1	50·1	22	N.	Light	,,	,,	2½ ,,	30·50	7
Station V.												
April 21.												
6.40 a.m.	S.	43·70	44·3	43·8	20	E.	4	Hazy.	Moderate.	4½ h. ebb.	29·76	3¾
8.15 a.m.	N.	44·24	44·0	43·9	15½	,,	,,	,,	,,	l. w.	29·79	3¾
May 20.												
8.40 a.m.	S.	47·30	47·3	45·0	23	N.E.	3	,,	,,	¾ h. fl.	30·21	7
9.35 a.m.	N.	48·74	47·3	45·0	10	,,	,,	,,	,,	1¾ ,,	30·19	7½
Sept. 24.												
10.0 a.m.	N.	53·96	54·0	53·0	19	W.N.W.	2	Overcast, with rain.	Slight.	5¾ ,,	29·49	7
11.40 a.m.	S.	53·60	54·0	51·8	30¼	W.N.W.	4	Overcast.	,,	1½ h. ebb.	29·52	5½
Station VI.												
April 5.												
9.15 a.m.	W.	40·46	43·8	43·7	35	S.E.	6	Clear.	Choppy.	1¼ h. fl.	29·98	6
11.15 a.m.	N.	41·90	43·3	43·4	18	,,	5	,,	,,	3¼ ,,	30·0	3
May 25.												
1.15 p.m.	W.	53·06	48·1	46·9	32½	N.W.	2	Cloudy.	Slight.	¼ h. fl.	29·75	7
3.10 p.m.	N.	52·52	49·1	47·1	21½	,,	,,	,,	,,	2¼ ,,	29·73	5¼
Sept. 15.												
8.20 a.m.	W.	55·94	56·0	55·2	26¾	W.	1	Dull, hazy.	Smooth.	Near l.w.	30·29	10½
10.35 a.m.	N.	56·30	55·2	55·0	20½	W.S.W.	1	Cloudy.	,,	2 h. fl.	30·26	8½

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

C. PHYSICAL OBSERVATIONS—II. FIRTH OF CLYDE—*continued*.

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station VII.												
1897. April 26.												
11.5 p.m.	N.E.	47·30	45·0	44·3	24	E.N.E.	4	Hazy.	Slight.	3 h. ebb.	30·01	..
12.55 a.m.	S.W.	46·22	45·6	44·1	24	,,	5	,,	Moderate.	4½ ,,	30·01	..
April 27.												
10.20 a.m.	N.E.	46·22	45·2	44·5	24	E.N.E.	5	Hazy.	Moderate.	1½ ,,	29·98	6
12.5 p.m.	S.W.	49·64	45·0	44·1	24	,,	,,	,,	,,	3 ,,	29·98	5¾
May 17.												
5.0 p.m.	N.E.	53·96	47·7	45·1	24½	,,	4	Slight haze.	,,	5½ ,,	30·32	7¼
6.45 p.m.	S.W.	56·66	47·5	45·0	27	,,	3	,,	Slight.	1 h. fl.	39·31	6
May 21.												
1.0 a.m.	S.W.	46·04	47·0	45·7	23	N.E.	4	Hazy.	Moderate.	4¼ ,,	30·10	..
2.50 a.m.	N.E.	46·40	46·1	45·4	24	,,	,,	,,	,,	About h.w.	30·10	..
Sept. 29.												
11.45 a.m.	S.W.	54·86	55·0	54·9	20	S.S.W.	3	Moderately clear.	Slight.	4 h. fl.	29·77	6
1.45 p.m.	N.E.	55·76	55·0	54·8	23¼	S. by W.	3	Clear.	,,	h.w.	29·74	9½
(Night haul.)												
7.0 p.m.	S.E.	55·22	55·0	54·9	25	S.S.W.	4	Cloudy.	,,	5 h. ebb.	29·70	..
9.10 p.m.	N.W.	54·86	54·5	54·7	28	S.	3	,, rain.	,,	1h. 10m. fl.	29·70	..
Station VIII.												
April 26.												
8.40 p.m.	W.	49·10	46·0	44·4	33	E.N.E.	3	Hazy.	Slight.	½ h. ebb.	29·97	..
10.30 p.m.	E.	47·66	45·2	44·4	28	,,	4	,,	,,	3¼ ,,	30·00	..
April 27.												
1.25 p.m.	E.	45·68	45·8	44·4	30	E.N.E.	5	,,	Choppy.	4½ ,,	29·96	6½
3.10 p.m.	W.	48·92	45·7	44·5	35	,,	,,	,,	,,	About l.w.	29·96	5
May 17.												
8.25 a.m.	W.	50·18	46·6	45·4	35	E.N.E.	2	Slight haze.	Moderate.	3 h. fl.	30·37	7
10.20 a.m.	E.	52·88	47·0	45·3	29	,,	4	,,	,,	5 ,,	30·36	8
May 20.												
10.0 p.m.	W.	51·44	47·1	46·0	33½	N.E.	3	Hazy.	Slight.	1¼ ,,	30·10	..
11.50 p.m.	E.	46·40	47·2	45·9	30	,,	5	,,	Choppy.	3 ,,	30·10	..
Sept. 29.												
10.20 p.m.	W.	55·76	55·0	55·0	42	S.S.W.	2	Cloudy.	Slight.	2¼ ,,	29·70	..
12.30 p.m.	E.	53·96	55·0	55·2	35	Light, variable.	0	,,	,,	4½ ,,	29·70	..
Sept. 29.												
7.45 a.m.	W.	51·98	54·8	55·0	34½	S.W.	2	Hazy, with rain.	,,	¼ ,,	29·80	10
9.40 a.m.	E.	53·06	54·8	54·5	29	S. by W.	2	Cloudy.	,,	2¼ ,,	29·80	10
Station IX.												
April 22.												
7.55 a.m.	S.W.	45·32	44·5	44·3	27½	E.N.E.	4	Slight haze.	Moderate.	4¾ h. ebb.	30·16	4
9.45 a.m.	N.E.	44·78	44·5	44·0	27½	E.	5	,,	,,	½ h. fl.	30·20	3¾
May 17.												
12.15 p.m.	N.E	56·12	47·4	45·4	28	E.N.E.	3	,,	Slight.	¾ h. ebb.	30·34	7
2.5 p.m.	S.W.	59·90	47·6	45·4	33	,,	4	,,	Moderate.	2½ ,,	30·34	7¼

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

C. PHYSICAL OBSERVATIONS—II. FIRTH OF CLYDE—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Baro-meter.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
1897.												
Sept. 28.												
1.30 p.m.	N.E.	56·66	54·7	54·4	30	S.	4	Hazy.	Moderate.	½ h. ebb.	29·96	10½
3.55 p.m.	S.W.	56·66	54·7	54·9	27¼	S.	5	,,	Choppy.	2½ ,,	29·92	10
Station X.												
April 28.												
7.55 a.m.	W.	46·04	45·2	44·7	27	Calm.	..	Fog.	Smooth.	5 h. fl.	29·97	7
9.45 a.m.	E.	46·76	45·0	44·4	28	N.N.W.	Light	,,	,,	¾ h. ebb.	29·99	8
May 22.												
11.50 a.m.	W.	56·12	48·0	47·0	27	N.E.	,,	Hazy.	,,	1 h. fl.	29·95	7
1.40 p.m.	E.	62·64	50·5	46·8	29	W.	,,	,,	,,	2¾ ,,	29·95	8
Sept. 15.												
11.55 a.m.	W.	57·74	55·9	55·4	28	W.S.W.	1	Slight haze.	,,	3½ h. fl.	30·24	7
1.45 p.m.	E.	59·72	56·2	55·3	28½	W.S.W.	2	Hazy.	Slight.	5¼ ,,	30·24	10
Station XI.												
April 21.												
3.25 p.m.	W.	46·40	45·0	43·9	35	E.	5	Hazy.	Moderate.	h w.	29·90	3½
5.10 p.m.	E.	48·02	45·0	44·0	22	,,	4	Slight haze.	,,	1¾ h. ebb.	29·92	4½
May 20.												
3.45 p.m.	E.	55·94	47·3	45·2	20	N.E.	2	Hazy.	Slight.	1¼ ,,	30·10	6½
5.30 p.m.	W.	56·66	47·4	45·1	35	,,	,,	,,	,,	3 ,,	30·10	6½
Sept. 27.												
10.20 a.m.	S.	56·84	54·1	53·8	35	S.W.	1	Cloudy.	,,	4 h. fl.	30·12	7½
12.30 a.m.	N.	59·72	54·3	53·8	25	S.W. by W.	1	Fine.	,,	¾ h. ebb.	30 15	6
Station XII.												
April 21.												
10.55 a.m.	W.	47·12	45·0	43·7	42	E.	4	Hazy.	Moderate.	1½ h. fl.	29·83	3½
1.0 p.m.	E.	47·66	45·3	44·0	47½	,,	5	,,	,,	3¾ ,,	29·86	3
April 28.												
9.0 p.m.	W.	46·76	45·4	44·5	47	S.W.	1	,,	Slight.	Near h.w.	30·01	..
11.0 p.m.	E.	46·04	45·4	44·3	48½	W.	1	,,	,,	1½ h. ebb.	30·02	..
May 20.												
11,40 a.m.	W.	51·44	47·1	44·8	43	N.E.	4	,,	,,	3¾ h. fl.	30·17	7
1.40 p.m.	E.	52·52	47·7	45·0	44	,,	2	,,	,,	5¾ ,,	30·12	7
May 26.												
10.0 p.m.	E.	49·28	50·0	45·2	45	S.	1	Slight haze.	,,	1¾ h. ebb.	29·42	..
12 midnight	W.	49·10	49·5	44·5	47	,,	..	,,	,,	3¾ ,,	29·42	..
Sept 24.												
1.55 p.m.	W.	53·96	54·0	51·6	43	W.S.W.	4	Cloudy.	Moderate.	3½ ,,	29·56	7½
4.5 p.m.	E.	54·86	54·5	54·0	37	W.S.W.	4	,,	,,	5½ ,,	29·60	4
Sept. 27.												
9.15 p.m.	W.	55·94	54·3	54·8	44	S.	3	,,	,,	3 h. fl.	30·12	..
11.50 p.m.	..	55·40	54·0	52·0	45	S.S.W.	2	Clear star-light.	Slight.	5¾ ,,	30·10	..

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1897.

C. PHYSICAL OBSERVATIONS—III. CLYDE (UPPER LOCH FYNE).

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Baro-meter.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Sur-face.	Bot-tom.	Depth in faths.	Direc-tion.	Force.					
Station XIII.												
1897.												
Mar. 30.												
1.5 p.m.	N.E.	39·56	44·0	43·9	27¾	Calm.	..	Overcast.	Smooth.	3½ h. ebb.	29·58	5
2.15 p.m.	S.W.	39·20	43·9	43·8	27¼	S.S.E.	Light	Snow showers.	,,	4¾ ,,	29·56	5½
May 27.												
5.0 a.m.	S.W.	46·04	48·4	45·0	34	E.S.E.	4	Hazy.	Slight.	1½ h. fl.	29·42	5
6.10 a.m.	N.E.	47·66	48·8	45·3	24½	S.E.	1	,,	,,	2¾ ,,	29·42	5
Aug. 4.												
11.0 a.m.	S.W.	68·56	59·0	49·1	34	W.N.W.	1	,,	Smooth.	Near l.w.	30·06	4¾
2.5 p.m.	N.E.	23·8	59·2	49·0	26	S.	2	,,	,,	3 h. fl.	30·02	4¾
Oct. 11.												
10.35 a.m.	S.W.	49·28	52·2	52·0	29	N. by W.	4	Cloudy.	Slight.	4¾ ,,	29·83	5½
12.45 a.m.	N.E.	49·46	52·0	52·2	38	N. by W.	3	,,	,,	h. w.	29·83	6¾
Dec. 14.												
9.30 a.m.	N.E.	41·72	47·6	50·8	25	S.	2	Clear, open.	Smooth.	l. w.	29·24	4½
11.15 a.m.	S.W.	43·88	47·2	51·0	35	S.	2	Moderately clear.	,,	2 h. fl.	29·26	5½
Station XIV.												
Mar. 30.												
11.30 a.m.	N.E.	39·74	43·1	43·9	25	W.	Light.	Cloudy.	Smooth.	1 h. ebb.	29·58	5
12·50 p.m.	S.W.	39·56	44·0	43·9	27¾	Calm.	..	Overcast.	,,	1¾ ,,	29·58	5
May 27.												
6.45 a.m	S.W.	47·66	48·8	45·7	24½	S.E.	1	Hazy.	Slight.	3¾ h. fl.	29·42	5
8.5 a.m.	N.E.	53·06	49·4	45·4	25	,,	,,	Slight haze.	Smooth.	5 ,,	29·43	4¾
July 29.												
10.0 a.m.	S.W.	59·36	56·0	48·0	35	W. by S.	1	Hazy.	,,	3½ ,,	30·14	5½
12.20 a.m.	N.E.	61·88	57·0	48·0	25	S.W.	2	,, and rain.	,,	4¾ ,,	30·16	5
Oct. 11.												
2.37 p.m.	N.E.	49·64	51·6	50·9	26	N.	3	Cloudy.	Slight.	2¾ h. ebb.	29·84	7
3.55 p.m.	S.W.	51.26	52·0	52·1	33	N.	Squ'ly	,,	,,	4½ ,,	29·86	6¼
Dec. 14.												
12.55 p.m.	N.E.	44·42	47·0	51·0	24	S.	1	,,	Smooqh.	3½ h. fl.	29·26	5
	S.W.	*See S*	*tation*	*XIII.*		S.						
Station XV.												
Mar. 30.												
8.55 a.m.	S.W.	34·70	43·2	44·1	27¼	Calm.	..	Cloudy .	Smooth.	4½ h. fl.	29·61	5
10.30 a.m.	N.E.	42·08	43·0	44·3	40½	W.	Light,	,,	,,	h. w.	29·60	5
May 27.												
8.55 a.m.	S.W.	51.44	49·3	44·8	25	S.E.	1	Slight haze.	,,	5¾ h. fl.	29·44	5
10.20 a.m.	N.E.	55·22	50·2	44·5	40	E.	1	Cloudy.	Slight.	¾ h. ebb.	29·45	5
July 28.												
9.45 a.m.	W.	59·0	56·0	47·0	29	W.S.W.	1	,,	Smooth.	4¼ h. fl	29·95	6
11.20 a.m.	E.	63.50	58·1	48·0	46	W.S.W.	1	Fine, cloudy.	,,	5¼ ,,	29·97	6½
Oct. 8.												
1.45 p.m.	E.	52·52	52·0	47·0	40½	W.	4	Showery.	Slight.	3 h. ebb.	29·92	5
3.30 p.m.	W.	51·98	52·0	48·0	35	Squally.	..	Cloudy.	,,	5 ,,	29·93	5½
Dec. 14.												
1.15 p.m.	S.W.	44·42	47·4	50·2	28	S.	2	Bright, open.	Moderate.	3¾ h. fl	29·24	5½
3.15 p.m.	N.E.	44·24	46·5	47·5	56	S.S.W.	1	Cloudy.	Smooth.	5¾ .,	29·26	6½

TABLE C.—Record of Observations made on Board the 'Garland' during 1897.

C. PHYSICAL OBSERVATIONS—III. Clyde (Upper Loch Fyne)—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station XVI. 1897. Mar. 29.												
2.30 p.m.	E.	44·24	45·0	44·6	53	N.N.E.	2	Cloudy.	Smooth.	4½ h. ebb.	29·55	6½
4.45 p.m.	W.	41·72	44·3	44·2	64	N.	2	,,	,,	½ h. fl.	29·56	4½
May 28.												
11.40 a.m.	E.	60·08	51·0	44·4	62	E.S.E.	3	Cloudy.	Slight.	1¼ h. ebb.	29·43	5
2.0 p.m.	W.	57·56	52·9	44·3	71	E.	1	Overcast.	,,	3½ ,,	29·40	5½
July 30.												
9.30 a.m.	S.W.	60·08	60·0	44·4	64	W.S.W.	2	Hazy.	Smooth.	2½ h. fl.	30·26	7
11.30 a.m.	N.E.	63·32	60·9	44·3	57	W.S.W.	1	,,	,,	4½ ,,	30·28	4
Aug. 5.												
8.15 a.m.	N.E.	..	64·5	44·4	55	E.N.E.	1	Hazy.	Smooth.	3 h. ebb.	29·89	7
10.5 a.m.	S.W.	..	64·0	43·8	63	S.	2	,,	,,	4¾ ,,	29·78	6¾
Oct. 8.												
9.55 a.m.	N.E.	51·80	52·1	44·8	64	W.	3	Rain.	Slight.	h.w.	29·92	3½
12.40 a.m.	S.W.	51·80	52·0	50·5	74	W.	4	Cloudy.	,,	2 h. 40 m. ebb.	29·92	5
Dec. 13.												
12.0 a.m.	N.E.	42·62	43·0	45·6	64	S.E.	Squ'ly	,, ,with showers.	Moderate.	3½ h. fl.	29·34	5
3.40 p.m.	S.W.	45·50	44·2	45·8	65	S.	2	Cloudy.	,,	1 h. ebb.	29·33	6
Station XVII.												
Mar. 29.												
7.50 a.m.	E.	36·50	41·0	44·0	16¼	W.N.W.	1	Cloudy.	Smooth.	3¾ h. fl.	29·47	4
9.20 a.m.	W.	40·10	43·6	44·5	36	,,	2	,,	,,	5¼ ,,	29·48	4¾
May 28.												
6.50 a.m.	W.	53·06	48·7	44·2	38	E.S.E.	Squ'ly	Slight haze.	Slight.	2½ ,,	29·46	4½
8.30 a.m.	E.	53·24	47·0	44·3	17	E.	1	Clear.	,,	4¼ ,,	29·45	4
July 30.												
12.45 p.m.	N.E.	67·28	61·0	47·1	17½	W.S.W.	1	Fine, clear.	Smooth.	Near h.w.	30·28	2½
1.50 p.m.	S.W.	68·00	63·3	44·9	37	W.S.W.	1	,, ,,	,,	¾ h. ebb.	30·28	3½
Oct. 6.												
8.45 a.m.	E.	45·32	53·5	50·9	16½	Calm.	0	Fog.	,,	1¾ ,,	30·30	4½
10.40 a.m.	W.	52·16	53·5	46·1	38	Variable	Slight airs.	Cloudy.	,,	3¼ ,,	33·30	5
Dec. 13.												
9.20 a.m.	N.E.	41·54	49·8	49·9	17½	S.E.	Squ'ly	Heavy rain.	Moderate.	¾ h. fl.	29·34	5
11.0 a.m.	S.W.	40·64	45·4	48·9	36	S.E.	,,	Rain.	,,	2½ ,,	29·34	6

TABLE D.—SHOWING THE QUANTITIES OF FISH CAUGHT BY LINE IN 1897 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

WICK DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	497	164	4,693	7·09	249	0·376	.	.	505	0·76	25	0·03	.	.	4	0·006	44	0·06	.	.	.	.	91	0·13	516	0·78	108	0·16	6,235	9·43
Feb.	870	306	8,103	6·89	756	0·642	.	.	480	0·408	66	0·056	.	.	5	0·004	78	0·066	.	.	16	0·013	64	0·054	736	0·64	95	0·08	10,426	8·86
March	650	147	3,089	3·875	287	0·36	.	.	505	0·63	31	0·038	.	.	.	.	65	0·081	.	.	42	0·052	20	0·024	358	0·44	22	0·027	4,419	5·53
April	270	367	5,034	7·9	649	1·018	.	.	1,400	2·19	78	0·12	.	.	2	0·003	148	0·23	.	.	24	0·037	14	0·021	560	0·87	44	0·069	7,953	12·5
May	104	259	2,715	7·479	33	0·09	10	0·027	1,372	3·72	94	0·25	.	.	.	.	10	0·027	.	.	4	0·011	.	.	40	0·11	34	0·093	4,312	11·87
June	67	160	2,100	9·25	.	.	.	.	770	3·39	2	0·008	.	.	.	.	3	0·013	.	.	.	.	.	.	10	0·044	71	0·31	2,956	13·02
July	950	165	1,119	1·003	20	0·017	.	.	248	0·22	51	0·045	.	.	.	.	1	0·0008	.	.	.	.	.	.	.	.	61	0·054	1,500	1·34
Aug.	450	103	590	1·06	9	0·016	.	.	132	0·23	83	0·15	.	.	.		6	0·01	.	.	.	.	.	.	.	.	58	0·104	878	1·58
Sept.	6	329	313	0·934	4	0·011	.	.	40	0·11	274	0·81	.	.	.	.	2	0·006	.	.	8	0·023	.	.	.	.	67	0·2	708	2·11
Oct.	.	416	368	0·884	11	0·026	.	.	225	0·54	273	0·65	.	.	.	.	.	.	.	.	24	0·057	.	.	.	.	30	0·072	931	2·23
Nov.	5	327	423	1·27	28	0·084	.	.	380	1·14	204	0·61	.	.	.	.	1	0·003	.	.	44	0·13	8	0·024	33	0·1	27	0·081	1,148	3·45
Dec.	42	523	1,324	2·34	142	0·251	.	.	515	0·91	184	0·32	.	.	.	.	33	0·06	.	.	10	0·018	210	0·37	330	0·68	44	0·076	2,792	4·94
Totals,	3,911	3,266	29,871	4·16	2,188	0·304	10	0·001	6,572	0·91	1,365	0·19	.	.	19	0·001	391	0·054	.	.	172	0·023	407	0·056	2,583	0·35	661	0·092	44,258	6·16

TABLE D.—*continued.*—LYBSTER DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	.	113	239	2·11	.	.	.	.	10	0·088	137	1·21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38	0·33	424	3·75
Feb.	120	121	979	4·062	.	.	.	.	142	0·58	175	0·72	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21	0·087	1,317	5·46
March	46	77	358	2·91	.	.	.	.	49	0·39	132	1·073	.	.	.	.	2	0·016	.	.	.	.	.	.	.	.	23	0·18	564	5·18
April	8	167	304	1·73	.	.	.	.	23	0·13	139	0·79	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19	0·108	485	2·77
May	.	153	256	1·67	.	.	.	.	83	0·54	230	1·503	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28	0·18	597	3·901
June	.	136	368	2·705	.	.	.	.	131	0·96	44	0·32	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32	0·23	575	4·22
July	10	69	181	2·29	.	.	.	.	63	0·79	10	0·12	.	.	.	.	.	.	.	.	.	.	3	0·037	.	.	30	0·37	287	3·63
Aug.	5	51	117	2·089	.	.	.	.	56	1·00	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	0·41	196	3·5
Sept.	7	113	222	1·85	.	.	.	.	52	0·43	160	1·33	.	.	.	.	.	.	.	.	.	.	12	0·1	.	.	87	0·72	533	4·44
Oct.	.	124	237	1·91	.	.	.	.	.	.	190	1·53	.	.	.	.	.	.	.	.	.	.	.	.	.	.	71	0·57	498	4·016
Nov.	.	123	206	1·67	10	0·081	.	.	13	0·105	175	1·42	.	.	.	.	.	.	.	.	7	0·056	.	.	.	.	35	0·28	446	3·62
Dec.	68	193	755	2·89	21	0·08	.	.	23	0·008	360	1·37	.	.	.	.	7	0·026	.	.	2	0·007	.	.	.	.	28	0·108	1,196	4·58
Totals,	264	1,440	4,222	2·47	31	0·018	.	.	645	0·37	1,752	1·028	.	.	.	.	9	0·005	.	.	9	0·005	15	0·008	.	.	435	0·25	7,118	4·22

TABLE D.—*continued*.—HELMSDALE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	158	202	1,534	4·26	15	0·041	.	.	185	0·51	421	1·16	6	0·016	.	.	7	0·019	.	.	.	.	74	0·20	20	0·055	.	.	2,262	6·28
Feb.	127	314	1,415	3·20	.	.	.	.	68	0·15	247	0·56	5	0·011	1	.	7	0·015	.	.	363	0·82	4	0·009	.	.	.	.	2,110	4·79
March	88	134	1,373	6·18	.	.	.	.	20	0·09	148	0·6	2	0·009	.	.	1	.	.	.	51	0·22	.	.	.	.	.	.	1,595	7·18
April	54	277	1,296	3·91	.	.	.	.	162	0·48	547	1·62	17	0·051	.	.	4	0·012	.	.	55	0·16	.	.	.	.	.	.	2,081	6·28
May	2	259	395	1·51	7	0·26	.	.	101	0·38	759	2·9	13	0·05	.	.	.	.	.	.	100	0·38	8	0·03	3	0·01	.	.	1,386	5·31
June	2	271	230	0·84	.	.	.	.	47	0·17	253	0·92	.	.	.	.	1	.	.	.	125	0·45	19	0·07	7	0·025	.	.	682	2·5
July	.	77	72	0·93	.	.	.	.	23	0·3	117	1·52	26	0·33	.	.	.	.	.	.	29	0·37	6	0·078	.	.	.	.	273	3·54
Aug.	.	53	42	0·79	.	.	.	.	10	0·18	45	0·84	3	0·056	.	.	.	.	.	.	63	1·18	5	0·094	10	0·18	.	.	178	3·35
Sept.	.	275	233	0·84	.	.	.	.	11	0·04	557	2·025	7	0·025	.	.	.	.	.	.	54	0·19	116	0·42	4	0·014	.	.	982	3·57
Oct.	.	402	348	0·84	10	0·024	.	.	19	0·047	258	0·64	3	0·007	.	.	8	0·02	3	0·007	206	0·51	296	0·73	73	0·18	.	.	1,224	3·03
Nov.	.	369	451	1·22	12	0·032	.	.	42	0·11	769	2·08	5	0·013	.	.	3	0·008	.	.	51	0·13	208	0·56	48	0·13	105	0·28	1,694	4·59
Dec.	35	377	931	2·25	.	.	.	.	52	0·14	1,435	3·48	17	0·041	.	.	2	0·004	.	.	47	0·11	65	0·15	36	0·087	96	0·23	2,681	6·50
Totals,	466	3,010	8,320	2·39	44	0·012	.	.	740	0·21	5,556	1·59	104	0·029	1	0·0002	33	0·009	3	0·0008	1,144	0·32	801	0·23	201	0·057	201	0·057	17,148	4·93

TABLE D.—*continued.*—CROMARTY DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.
Jan.	.	584	705	1·2	.	.	.	.	.	.	1,189	2·035	.	.	.	.	.	.	.	.	11	0·018	33	0·056	.	.	55	0·094	1,993	3·41
Feb.	.	721	276	0·38	.	.	.	.	.	.	1,553	2·15	.	.	.	.	.	.	.	.	171	0·23	.	.	.	.	54	0·074	2,054	2·86
March	3	401	255	0·63	.	.	.	.	.	.	595	1·47	.	.	.	.	.	.	.	.	133	0·32	.	.	.	.	49	0·12	1,032	2·55
April	.	580	471	0·81	.	.	.	.	2	.	777	1·33	.	.	.	.	.	.	.	.	70	0·12	.	.	.	.	134	0·23	1,454	2·50
May	.	381	307	0·8	.	.	.	.	4	0·01	552	1·44	.	.	.	.	.	.	.	.	16	0·04	.	.	.	.	81	0·21	960	2·51
June	.	379	398	1·05	.	.	.	.	3	.	587	1·51	.	.	.	.	.	.	.	.	21	0·055	.	.	.	.	105	0·27	1,114	2·93
July	.	167	96	0·57	.	.	.	.	.	.	279	1·67	12	0·07	.	.	.	.	.	.	15	0·089	.	.	.	.	106	0·64	508	3·041
Aug.	.	208	104	0·5	.	.	.	.	.	.	372	1·78	22	0·10	.	.	.	.	.	.	25	0·12	.	.	2	0·009	99	0·47	624	3·00
Sept.	.	514	172	0·34	.	.	.	.	.	.	513	1·00	.	.	.	.	.	.	.	.	173	0·33	.	.	.	.	130	0·25	988	1·92
Oct.	.	693	264	0·38	.	.	.	.	1	.	809	1·17	.	.	.	.	.	.	.	.	31	0·044	9	0·013	1	.	106	0·15	1,221	1·76
Nov.	.	611	238	0·38	.	.	.	.	.	.	775	1·26	.	.	.	.	.	.	.	.	13	0·021	.	.	.	.	112	0·18	1,138	1·86
Dec.	.	679	366	0·53	.	.	.	.	.	.	1,166	1·71	.	.	.	.	.	.	.	.	.	.	5	0·007	2	0·002	111	0·16	1,650	2·40
Totals,	3	5,918	3,652	0·61	.	.	.	.	10	0·001	9,167	1·54	34	0·005	.	.	.	.	.	.	679	0·11	47	0·007	5	0·0008	1,142	0·19	14,736	2·48

TABLE D.—*continued.*—FINDHORN DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	425	1,159	1,231	0·77	29	0·012	.	.	112	0·07	3,818	2·41	129	0·081	1	0·0006	2	0·001	.	.	10	0·006	13	0·003	41	0·025	8	0·005	5,394	3·40
Feb.	484	1,409	1,871	0·98	50	0·026	.	.	104	0·054	6,365	3·36	13	0·006	3	0·001	16	0·008	.	.	306	0·016	.	.	40	0·021	19	0·01	8,787	4·64
March	585	1,179	2,094	1·18	33	0·018	.	.	50	0·028	5,426	3·075	87	0·049	2	0·001	15	0·008	.	.	487	0·27	.	.	24	0·013	22	0·012	8,243	4·67
April	369	1,021	1,546	1·11	42	0·03	.	.	25	0·18	4,321½	3·043	6	0·004	.	.	3	0·002	.	.	321	0·23	.	.	3	0·002	15	0·01	6,190	4·45
May	182	693	593	0·67	.	.	.	.	79	0·089	1,092	1·23	19	0·021	.	.	1	0·001	.	.	77	0·087	.	.	.	.	20	0·022	1,881	2·12
June	183	824	227	0·22	.	.	.	.	94	0·093	1,274	1·26	61	0·061	.	.	.	.	.	.	58	0·057	.	.	.	.	26	0·025	1,740	1·72
July	389	505	108	0·12	.	.	.	.	21	0·023	916	1·02	133	0·14	.	.	.	.	.	.	2	0·002	.	.	.	.	17	0·019	1,197	1·33
Aug.	898	437	83	0·061	.	.	.	.	36	0·026	787	0·58	116	0·086	.	.	.	.	.	.	78	0·058	.	.	.	.	40	0·03	1,140	0·85
Sept.	273	1,195	337	0·22	.	.	.	.	4	0·002	2,490	1·69	43	0·029	.	.	.	.	.	.	217	0·14	.	.	.	.	30	0·02	3,121	2·12
Oct.	304	1,424	229	0·13	.	.	.	.	.	.	2,161	1·25	27	0·015	.	.	.	.	.	.	27	0·015	5	0·002	2	0·001	14	0·008	2,465	1·42
Nov.	294	1,528	301	0·16	.	.	.	.	.	.	2,314	1·27	9	0·004	.	.	.	.	.	.	117	0·064	.	.	.	.	3	0·001	2,744	1·5
Dec.	352	1,486	571	0·31	.	.	.	.	58	0·032	2,986	1·67	142	0·079	.	.	.	.	.	.	2	0·001	.	.	7	0·003	27	0·015	3,793	2·12
Totals,	4,738	12,810	9,191	0·52	154	0·008	.	.	588	0·033	33860½	1·92	785	0·044	6	0·0003	37	0·002	.	.	1,702	0·097	18	0·001	117	0·006	241	0·013	46,694	2·66

TABLE D.—*continued*.—BUCKIE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average
Jan.	446	515	4,115	4·29	263	0·27	.	.	612	0·63	2,098	2·18	.	.	.	.	34	0·035	.	.	.	.	69	0·071	449	0·46	210	0·218	7,850	8·16
Feb.	505	683	5,245	4·41	120	0·101	.	.	234	0·19	6,062	5·102	.	.	.	.	43	0·036	.	.	.	.	3	0·002	182	0·15	381	0·32	12,270	10·32
March	555	105	4,759	7·21	67	0·101	.	.	165	0·25	3,151	4·77	.	.	.	.	37	0·056	.	.	.	.	.	.	103	0·15	205	0·31	8,487	12·85
April	271	456	1,312	1·804	.	.	.	.	122	0·16	2,584	3·55	.	.	.	.	8	0·011	.	.	2	0·002	.	.	76	0·026	145	0·19	4,249	5·84
May	.	674	564	0·83	.	.	.	.	57	0·084	1,280	1·89	.	.	.	.	.	.	.	.	.	.	.	.	.	.	250	0·37	2,151	3·19
June	.	779	470	0·603	.	.	.	.	72	0·092	954	1·22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	145	0·18	1,641	2·106
July	.	308	81	0·26	.	.	.	.	.	.	360	1·16	35	0·11	.	.	11	0·035	.	.	.	.	53	0·17	6	0·019	25	0·081	571	1·85
Aug.	.	149	19	0·12	.	.	.	.	.	.	249	1·67	2	0·013	.	.	.	.	.	.	.	.	2	0·013	2	0·013	14	0·093	288	1·93
Sept.	100	659	265	0·34	.	.	.	.	.	.	1,521	2·003	10	0·013	.	.	.	.	.	.	2	0·002	.	.	.	.	163	0·21	1,961	2·58
Oct.	269	1,095	189	0·13	.	.	.	.	.	.	2,415	1·77	.	.	.	.	.	.	.	.	12	0·008	.	.	.	.	175	0·12	2,791	2·046
Nov.	224	1,187	281	0·19	.	.	.	.	.	.	3,282	2·32	3	0·002	.	.	.	.	.	.	10	0·007	.	.	.	.	160	0·11	3,737	2·64
Dec.	167	1,333	339	0·22	3	0·002	.	.	.	.	3,593	2·39	.	.	.	.	.	.	.	.	2	0·001	.		.	.	135	0·09	4,072	2·71
Totals,	2,537	7,943	17,639	1·68	453	0·043	.	.	1 262	0·12	27,549	2·62	50	0·004	.	.	133	0·012	.	.	28	0·002	127	0·012	818	0·078	2,008	0·18	50,067	4·77

TABLE D.—*continued.*—BANFF DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	237	1,314	831	0·53	132	0·085	.	.	129	0·083	4,098	2·64	147	0·094	.	.	19	0·012	.	.	13	0·008	21	0·013	34	0·021	182	0·11	5,606	3·61
Feb.	236	1,794	602	0·29	100	0·049	.	.	130	0·064	12,412	6·11	178	0·087	.	.	10	0·004	.	.	15	0·007	23	0·011	46	0·022	238	0·11	13,754	6·77
March	415	944	551	0·405	146	0·107	.	.	77	0·056	6,489	4·77	161	0·11	.	.	26	0·019	.	.	25	0·018	.	.	84	0·061	230	0·16	7,789	5·73
April	195	1,895	568	0·27	84	0·04	10	0·004	427	0·204	6,501	3·11	170	0·081	.	.	8	0·003	.	.	9	0·004	.	.	16	0·007	159	0·076	7,952	3·79
May	5	787	325	0·41	46	0·058	5	0·006	241	0·304	1,889	1·75	108	0·13	.	.	22	0·027	.	.	.	.	15	0·018	10	0·012	112	0·14	2,273	2·87
June	.	524	173	0·33	8	0·015	.	.	200	0·38	747	1·42	85	0·16	.	.	3	0·005	.	.	11	0·02	.	.	10	0·019	56	0·106	1,298	2·47
July	.	376	114	0·303	10	0·026	.	.	252	0·67	589	1·56	55	0·14	.	.	.	.	.	.	6	0·015	.	.	5	0·013	80	0·21	1,111	2·95
Aug.	.	331	33	0·099	2	0·006	.	.	139	0·41	372	1·12	30	0·09	.	.	.	.	.	.	10	0·03	.	.	.	.	53	0·16	639	1·93
Sept.	120	1,565	135	0·08	7	0·004	.	.	75	0·044	3,789	2·24	295	0·17	.	.	.	.	.	.	30	0·017	.	.	9	0·005	296	0·17	4,636	2·75
Oct.	308	1,744	389	0·19	25	0·012	.	.	66	0·032	4,838	2·36	580	0·28	.	.	3	0·001	.	.	36	0·017	.	.	3	0·001	262	0·12	6,202	3·029
Nov.	340	1,797	430	0·201	23	0·01	.	.	92	0·043	4,048	1·89	357	0·16	.	.	.	.	.	.	52	0·024	.	.	3	0·001	184	0·086	5,189	2·42
Dec.	269	1,378	2,685	1·63	91	0·055	.	.	121	0·073	1,510	0·91	180	0·109	.	.	13	0·007	11	0·006	37	0·022	59	0·035	55	0·033	123	0·074	4,885	2·95
Totals,	2,120	14,449	6,836	0·41	674	0·04	15	0·0009	1,949	0·11	46,782	2·82	2,346	0·14	.	.	104	0·006	11	0·006	244	0·014	118	0·006	275	0·016	1,975	0·11	61,829	3·701

TABLE E.—TOTAL QUANTITIES OF FISH CAUGHT BY LINE IN 1897 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

Districts.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger-Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Wick, .	3,911	3,266	29,871	4·16	2,188	0·304	10	0·001	6,572	0·91	1,365	0·19	.	.	9	0·001	391	0·054	.	.	172	0·023	407	0·056	2,583	0·35	661	0·092	44,258	6·16
Lybster,	264	1,440	4,222	2·47	31	0·018	.	.	645	0·37	1,752	1·028	.	.	.	.	9	0·005	.	.	9	0·005	15	0·008	.	.	435	0·25	7,118	4·22
Helmsdale,	466	3,010	8,320	2·39	44	0·012	.	.	740	0·21	5,556	1·59	104	0·029	1	0·0002	33	0·009	3	0·0008	1,144	0·32	801	0·23	201	0·057	201	0·057	17,148	4·93
Cromarty,	3	5,918	3,652	0·61	.	.	.	.	10	0·001	9,167	1·54	34	0·005	.	.	.	.	.	.	679	0·11	47	0·007	5	0·0008	1,142	0·19	14,736	2·48
Findhorn,	4,738	12,810	9,191	0·52	154	0·008	.	.	583	0·033	33,860½	1·92	785	0·044	6	0·0003	37	0·002	.	.	1,702	0·097	18	0·001	117	0·006	241	0·013	46,694	2·66
Buckie,	2,537	7,943	17,639	1·68	453	0·043	.	.	1,262	0·12	27,549	2·62	50	0·004	.	.	133	0·012	.	.	28	0·002	127	0·012	818	0·078	2,008	0·18	50,067	4·77
Banff, .	2,120	14,449	6,836	0·41	674	0·04	15	0·0009	1,949	0·11	46,782	2·82	2,346	0·14	.	.	104	0·006	11	0·0006	244	0·014	118	0·006	275	0·016	1,975	0·11	61,329	3·701
Totals,	14,039	48,836	79,731	1·26	3,544	0·056	25	0·0003	11,761	0·18	126031½	2·004	3,319	0·052	16	0·0002	707	0·011	14	0·0002	3,978	0·063	1,533	0·024	3,999	0·063	6,663	0·105	241,350	3·83

II.—ON THE GROWTH AND MATURATION OF THE OVARIAN EGGS OF TELEOSTEAN FISHES. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent. (Plates I.—III.)

Exact knowledge concerning the mature eggs of the great majority of marine osseous fishes is of comparatively recent date. The structure or anatomical relations of the reproductive organs were early made the subject of investigation by such authorities as Rathke, Cuvier and Valenciennes, Vogt, Owen, Hyrtl, and Waldeyer; and the eggs, embryology, and development of several species were studied before 1866 by Rathke, Von Baer, Rusconi, Vogt, Doyère, Joh. Müller, Lereboullet, Stricker, Steenstrup, Ransom, and others. Since the year named a large number of investigations have been made by various naturalists, especially, perhaps, in connection with embryology. Previous to the period indicated, the researches on teleostean embryology were confined either to fresh-water species or to one or two marine shore forms, in which the eggs are carried by one of the parents until they hatch, namely the pipe-fishes (*Syngnathus*) and the viviparous blenny (*Zoarces viviparus*), and which, therefore, provided specimens at various stages of development. The fresh-water species which formed the subject of study were principally the perch, pike, carp, trout, salmon, chub, river-bullhead, ruffe, and sticklebacks. One reason why the early investigations were almost entirely confined to fresh-water forms was no doubt the comparative ease with which living eggs could be obtained, the relatively large size of the eggs, and the convenience with which they could be preserved alive. But there was another reason, inasmuch as previous to the time named scarcely anything was known about the eggs or oviposition of marine Teleosteans. It was not until the discoveries of Sars respecting the eggs and spawning of the cod, haddock, and mackerel that the attention of zoologists was specially directed to the importance of the subject. Since that time, although researches have naturally continued to be made on fresh-water forms, by far the greater number have concerned marine species; a circumstance also due to the establishment of marine laboratories in various countries, which have provided facilities that did not previously exist.

In 1864 G. O. Sars, in the course of an investigation into the cod fisheries of the Loffoden Isles, discovered that the mature eggs of the cod consisted of minute, perfectly transparent spheres, which floated about separately in the surface waters of the sea. In the following year he artificially fecundated the eggs of this fish and studied the development of the embryo; and he also found that the eggs of the haddock and of the mackerel were buoyant like those of the cod, as well as the eggs of some other species which he succeeded in hatching but not in identifying.* In 1867 A. W. Malm incidentally studied the eggs of the flounder, which were found to be buoyant.† In the following year Kupffer published an important paper on the development of osseous fishes, dealing principally with marine forms (*Gasterosteus spinachia*, *Gobius minutus*, *G. niger*).[*] In 1874 Hackel[†] and E. Van Beneden[‡] studied the development of unidentified pelagic fish-eggs in the Mediterranean; and from about that time, and especially during the last ten or fifteen years, a large number of memoirs and papers dealing with the eggs and the embryology of teleostean fishes have been published in this country, principally by Professor M'Intosh, Mr J. T. Cunningham, and Mr E. W. L. Holt.

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* "Om Vinterstorskens (*Gadus morrhua*) Forplanting og Udvikling." *Forhand. i Videnskabs-Selsk. i Christiania, aar 1865*, p. 237 (1866); Indberetninger til Departmentet for det Indre, 1864-78, Christiania, 1879. (Translations of these reports, except the last, are published in the Report of the U.S. Fish Commission for 1877.)

† "Bidrag till Kännedom af Pleuronektoidernes utveckling och byggnad." *Konigl, Svenska Vetenskaps Akad. Handlingar*, p. 1. 1867.

The researches that have been made on the eggs and embryology of marine Teleosteans since the discoveries of Sars, while of great value from the scientific point of view, have been also of direct practical importance in showing that the eggs are in the great majority of species buoyant or pelagic, and that those which are demersal are, for the most part, shore forms, which, with the exception of the herring, are of little economic utility. All the Gadoids (except *Lota vulgaris*, which is a fresh-water form) and the European flat-fishes have pelagic eggs, as have also the mackerel, pilchard, anchovy, sprat, the gurnards, and many others. On the other hand, none of the species which spawn in fresh water or in estuaries have pelagic eggs, for a reason which will be apparent later.

The investigations described in this paper deal mainly with the later stages in the ovarian development of the teleostean ovum, especially the maturation of the pelagic ovum, and with certain phenomena which arise in consequence of the changes which occur.

The most important point which I have been able to determine is that the final change in the maturation of the pelagic ovum, while still within the ovary, is accompanied by a comparatively rapid and relatively great accession of a watery fluid, of low density, from without, which dissolves the yolk-spherules, is associated with the dissolution of the germinal vesicle, and the definite formation of the periblast, distends the ovum to three or four times its former volume, thinning the capsule correspondingly, renders it of crystalline transparency, and reduces its specific gravity so that it is enabled to float in sea-water of ordinary density—in other words, to become pelagic. I have also been able to establish the fact that this change likewise occurs in the demersal eggs of Teleosteans at maturation, but to a less extent, the quantity of fluid absorbed being much smaller in amount, and the yolk-spherules remaining comparatively little affected.

The process is different from the ordinary slow growth of the eggs within the follicle. It is a rapid physical or physico-chemical change which is associated with the dissolution of the germinal vesicle and the rearrangement of the chromatin for fertilisation—the phase marking the completion of ovarian growth and the preparation of the egg for fertilisation—but which has, so to speak, in the pelagic egg, been seized upon and exaggerated by natural selection for another purpose—namely, to enable the eggs to float and to become widely dispersed.

The solution of the spherules and the dilution of the nutritive yolk by several times its volume of water, explains a number of phenomena hitherto obscure in the development of the embryo of pelagic eggs, such as its comparatively brief duration, the absence of true vitelline circulation, the simple mode by which the yolk is absorbed, the rapidity with which it is absorbed in the larval stage, and the relatively small and ill-developed condition of the larva. It is obvious that since the substance of the embryo and larva is almost entirely derived from the yolk, an egg in which the yolk has been diluted with three or four times its bulk of watery fluid has only a third or a fourth of the nutritive power of one in which the yolk remains in its original state ; and that, other things being equal, the physiological transformation of yolk into embryo ought, in such a case, to be both more rapid and easy, and the resulting embryo either smaller or less developed or both. In this sense, so far as concerns nutritive value, the mature demersal egg is comparable, not to the mature pelagic egg, but rather to the preceding opaque stage, although, as will be shown later, the initial nutritive value of the latter, unit for unit, is in reality inferior.

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[*] "Beobachtungen über d. Entwickelung d. Knochenfische." *Arch. f. Mikr. Anat., Bd. iv.*, p. 209. 1868.

[†] Die Gastrula und die Eifurchung der Thiere. *Jena Zeitschr.* ix., 1875.

[‡] A contribution to the History of Embryonic Development of Teleosteans. *Quart. Journ. Micr. Sci.* xviii., 1878.

A knowledge of the nature of the yolk in pelagic eggs likewise explains the gradual sinking of the larvæ after they are hatched, and even in some cases of the egg containing the advanced embryo. It is in virtue of the watery yolk of low specific gravity that the egg floats, and as this becomes used up in the growth of the little fish, to which it is attached, and transformed into its denser tissues, the specific gravity of the whole is increased, until it exceeds that of the sea water in which it is immersed. Hence the general rule that pelagic eggs are obtained in the surface layers of the sea, while the larvæ are found most abundantly towards the bottom and in the middle layers. The expansion of the pelagic ovum at maturation will also be afterwards shown to be correlated in certain important respects with the life-history of the species.

That the fully mature pelagic ovum of Teleosteans is translucent and larger than the opaque eggs present at the same time in the ovary has long been known, but I have been unable to find in any of the numerous papers dealing with them any indication of the real change which occurs. As will be more fully explained later, the descriptions given by various authors afford no hint that it is due to a special cause. The reason that this stage has hitherto escaped close attention is most probably owing to the circumstance that the few who have concerned themselves with ovarian pelagic eggs have, for the most part, studied only sections of the ovary, showing the immature or opaque ova, while those who have dealt with the fully mature eggs have almost always been concerned with the changes following fertilisation, or with their identification and morphological description ; perhaps also from failure to keep clearly in mind the fact that a small increase in the diameter of a sphere represents a large increase in its volume.

The methods adopted in my investigations were as follows :—(1), The examination of the immature and ripe ovaries in the living fish or in the fresh state ; (2), the microscopical examination of parts of the fresh ovaries and of the ovarian eggs at various stages, without preparation, in various media ; (3), the study of stained and mounted sections prepared in the usual way ; (4), the determination in certain cases of the general nature and quantity of the intra-ovarian fluid present in ripening ovaries; (5), experimental observations on the physical properties of the opaque and the mature eggs, and on some other points. It became evident to me that an adequate explanation of the chemical processes that occur in the maturation of the eggs could only be obtained by the assistance of an expert in physiological chemistry. The Board accordingly appointed Dr. T. H. Milroy, assistant to the Professor of Physiology in the University of Edinburgh, for this purpose. The thesis embodying my results was submitted to Dr. Milroy, whose report will be found at page 135 of this Report.

The species whose ovaries and eggs have been studied comprise the following :—

A.—With Dispersed Pelagic Eggs.

Grey Gurnard (*Trigla gurnardus*).
Red Gurnard (*Trigla cuculus*).
Lesser Weever (*Trachinus vipera*).
Mackerel (*Scomber scomber*).
Dragonet (*Callionymus lyra*).
Cod (*Gadus morrhua*).
Haddock (*Gadus æglefinus*).
Bib (*Gadus luscus*).
Whiting (*Gadus merlangus*).
Saithe (*Gadus virens*).
Ling (*Molva vulgaris*).
Four-Bearded Rockling (*Motella cimbria*).
Tusk (*Brosmius brosme*).
Halibut (*Hippoglossus vulgaris*).
Long Rough Dab (*Hippoglossoides platessoides*).
Turbot (*Rhombus maximus*).
Brill (*Rhombus lævis*).
Sail-Fluke (*Arnoglossus megastoma*).
Plaice (*Pleuronectes platessa*).
Lemon Dab (*Pleuronectes microcephalus*).
Witch (*Pleuronectes cynoglossus*).
Common Dab (*Pleuronectes limanda*).
Flounder (*Pleuronectes flesus*).
Sole (*Solea vulgaris*).
Solenette (*Solea lutea*).
Norwegian Topknot (*Zeugopterus norvegicus*).

B.—With Floating Eggs Imbedded in Mucus.

Angler or Monk (*Lophius piscatorius*).

C.—With Demersal Eggs.

Short-Spined Cottus (*Cottus scorpius*).
Long-Spined Cottus (*Cottus bubalis*).
Pogge (*Agonus cataphractus*).
Lumpsucker (*Cyclopterus lumpus*).
Diminutive Sucker (*Liparis montagui*).
Catfish (*Anarrhichas lupus*).
Lesser Sand-Eel (*Ammodytes tobianus*).
Smelt (*Osmerus eperlanus*).
Herring (*Clupea harengus*).

The immature ovaries of the common eel (*Anguilla vulgaris*) and of the John Dory (*Zeus faber*) were also examined. The latter are described in another place together with those of the angler (see p. 125). The eggs of the eel, according to the recent researches of Grassi and Calandruccio,* are buoyant.

Stained and mounted sections of the following species were examined :—Haddock, whiting, bib, grey gurnard, plaice, lemon sole, flounder, common dab, witch, sole, solenette, Norwegian topknot, long rough dab, John Dory, sand-eel, gunnel, herring, viviparous blenny, angler, catfish, and common eel. The eggs and portions of ovaries of the following species were examined microscopically in the living or fresh condition :—Cod, haddock, whiting, ling, saithe, bib, four-bearded rockling, grey gurnard, red gurnard, turbot, brill, halibut, plaice, lemon sole, witch, common dab, flounder, sole, solenette, Norwegian topknot, John Dory, herring, catfish, lumpsucker, pogge, short-spined cottus.

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* The Reproduction and Metamorphosis of the Common Eel. *Quart. Journ. Micr. Sci.*, Vol. xxxiii, Part iii. p. 3. 1896.

THE OVARIES.

The anatomy and structure of the ovaries of Teleostei have been described by His,* Brock,† Macleod,‡ and others. Such points in the minute structure as bear upon my subject will be explained later when dealing with the maturation of the ovarian eggs. It is, however, desirable here to refer to some general features of the ovary in species which produce pelagic eggs and in those whose eggs are demersal. If the ovaries of either form be examined before the advent of spawning, they will be found to be composed for the most part of relatively large, yolked, opaque eggs, destined to be extruded in the approaching spawning season. Among almost all forms with demersal eggs the difference in size, as well as in appearance, between these large eggs and the small eggs which are present in the ovary at the same time is very marked; and further, the large eggs approaching maturity are all of nearly equal size. For example, in the lumpsucker (*Cyclopterus lumpus*) the great mass of the eggs range about 2·2mm. in diameter, while the largest of the small eggs scattered about in the stroma do not exceed 0·4mm. It is the same with many other forms, such as the catfish, the herring, the smelt, the salmon, &c.; the two sizes of eggs being sharply demarcated from one another, and the larger being subequal in size. This condition is associated with rapid oviposition, the whole of the large eggs being extruded *en masse*, as with the lumpsucker, or at brief intervals, as with the herring and the smelt. In some other species with demersal eggs, such as the sticklebacks (*Gasterosteus*), the pipe-fishes (*Syngnathus*), and the diminutive suckers (*Liparis*), three series of eggs may be observed, each marked off from the other by difference in size, the two larger classes both containing yolk. Thus in *Liparis montagui*, at the spawning season, mature eggs practically of uniform size (1·1 to 1·2mm.) are present in the ovaries together with a series ranging from about 0·5 to 0·7, and a third series of minute, clear, yolkless eggs not exceeding 0·2mm. This condition is met with in small species in which comparatively few eggs are deposited at one time, and which shed their eggs in more than one batch or lot during the season. The successive spawnings have been specially observed among the sticklebacks.§

In species which produce pelagic eggs there is not always the same sharp demarcation between the large, yolked eggs, and those that are small and transparent. Gradations in size may be detected between the two groups, but the degree in which this transition exists varies very much in different species. In the larger forms, such as the cod, ling, plaice, tusk, and turbot, there are comparatively few eggs of intermediate size, while in the haddock, and especially in the whiting and gurnard, the intermediate eggs are very numerous, and the gradation between the largest and the smallest is readily perceived. This condition is associated with a prolonged spawning period, and there is thus time for the smaller yolked eggs to grow larger and to be expelled at the close of the spawning period. In the larger forms, oviposition, although still prolonged over several weeks, owing to the changes at maturation, is more rapid, the eggs shed in a given season being all pretty equally developed when spawning begins.

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* Untersuch. über das Ei und die Eientwickelung bei Knochenfischen. Leipzig, 1873.

† Beiträge z. Anat. und Histologie der Geschlechtsorgane der Knochenfische. *Morph. Jahrb.* iv., p. 505. 1878.

‡ Recherches sur la structure et le développement de l'Appareil reproducteur femelle des Téléosteans. *Arch. de Biologie*, Tome ii., p. 497. 1881.

§ Ransom. Observations on the Ovum of Osseous Fishes. *Phil. Trans. Roy. Soc. London*, Vol. clvii., p. 431. 1868.

If we now compare the fully mature ovaries of a Teleostean whose eggs are pelagic with those of one whose eggs are demersal, a striking difference will be perceived. In the latter, as already indicated, the eggs which are shed are developed equally; they grow gradually until they reach a certain size, practically uniform in a given species, they become more pellucid or semi-translucent, and are then expelled. But in species with pelagic eggs, examination of the ovary reveals the presence of large, clear eggs of crystalline transparency, scattered throughout its substance, presenting a marked contrast both in size and appearance to those around them which are whitish, opaque, and smaller. These are the mature ova ready to be shed and fertilised. They have burst through their follicles, they gradually accumulate in the lumen of the ovary, and are normally expelled in small quantities at a time.* It is important to observe that extremely few eggs of intermediate size or character are to be found between the opaque ones and the large transparent ones. The proportional number of the transparent eggs present in the ovaries depends upon the period in relation to the beginning or end of oviposition. At the commencement of spawning, very few are present. The proportion increases as the spawning proceeds, and towards the end the cavities of the ovaries are distended almost exclusively with the clear mature eggs.

THE FREE OVARIAN FLUID.

Little attention has hitherto been given to the free fluid which is found in the ovaries of Teleosteans bathing the lamellæ and the mature eggs. It has generally been regarded (1) as a lubricant to facilitate the escape of the eggs during oviposition; (2) in certain forms as a cementing substance to bind the deposited eggs to one another or to foreign bodies. Among attached or adherent demersal eggs, adhesion is sometimes effected by a special modification of the cortical part of the egg-membrane, sometimes by the stickiness of the outer surface, and sometimes by the hardening of the fluid which bathes the eggs and is expelled with them. In another group the eggs are imbedded in a mucoid substance which causes them to float, as in *Scorpæna*,† *Fierasfer*,‡ and *Lophius piscatorius*.§ I have shown elsewhere (p. 127) that the mucoid matrix that surrounds the eggs in *Lophius* is secreted by specially modified epithelium. In species producing isolated pelagic eggs the ovarian fluid which is expelled with the eggs when they are shed is watery; it mingles with the sea water and disappears. In immature ovaries the quantity of free fluid present is very small, just sufficient to keep the surfaces of the lamellæ wetted, but in those in which spawning has begun the quantity is considerable; and as it appeared to me that the nature and composition of this fluid might be closely related to that which enters the eggs at maturation, special attention has been paid to it.

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* It is sometimes supposed that the female sheds her pelagic eggs at random, and that fertilisation is to a large extent a matter of chance; but this is not the case. One or more males are in close attendance and impregnate the eggs as they escape in small quantities.

† Hoffman. Zur Ontogenie der Knochenfische. *Verhandel. der Koninkl. Akad. van Wetensch.* Deel. 21, p. 17, 1881; Raffaele, Le Uova gallegianti e le larve dei Teleostei nel Golfo di Napoli. *Mittheil. aus der Zool. Stat. zu Neapel, Bd.* viii., 1888.

‡ Emery, Fierasfer. Studî intorno alla sistematica, l'anatomia e la biologia delle specie mediterranee di questo genere Fauna and Flora des Golfes von Neapel. 1880.

§ Agassiz and Whitman. The Development of Osseous Fishes. *Mem. Mus. Comp. Zool. Harvard College*, xiv., No. i., Part ii. 1889.

Very little seems to be known concerning the normal ovarian fluids of any group.* The only reference I have found to it in Teleosteans—apart from the mere statement of the presence of a "lubricating" fluid—is in a paper by Hensen on the occurrence and quantity of the eggs of some Baltic fishes.† Hensen, in order to determine the precise specific gravity of the mature eggs of the cod when they are expelled from the oviduct, first ascertained the specific gravity of the eggs and fluid combined, and then the specific gravity of the fluid when separated from the eggs. He found the fluid from the ovaries of the cod to have a specific gravity, as determined by the piknometer, of 1·01115, at a temperature of 8·7° C.; he described it as alkaline and as containing an albuminoid substance which separated on boiling or by the addition of acetic acid, and which on precipitation by alcohol could not again be dissolved. He found the quantity of the liquid to vary greatly, but to range as a rule between fourteen and twenty per cent. of the total volume of the matter discharged from the ovaries in the cod. Hensen supposes the fluid to originate in the Graffian follicles, and he terms it accordingly *liquor folliculi.*

Before I was aware of Hensen's observations I examined the fluid from the ovaries of certain species by cutting open the organ and suspending it over a beaker covered with muslin. In this way from the ovaries of a ling, which had just begun to spawn, and which (the ovaries) weighed 5lbs. 6½oz., the quantity of fluid which drained off in the course of fifteen hours was 122 cubic centimetres. From the ovaries of a cod, which had been spawning for a short time, and which weighed 6lbs. 2oz., the quantity in thirteen hours measured 182 cubic centimetres; and in the same period the ovaries of a saithe weighing 3lbs. 2oz., in which the great mass of the organ was composed of mature transparent eggs, yielded 78 cubic centimetres. In each case the fluid was a little turbid and left a very faint stickiness on the fingers; it had a saltish taste, was practically neutral in reaction, and on heating it a fairly copious white coagulum was formed. The specific gravity, determined by a hydrometer, was after correction for temperature 1·012 in that from the ling, and 1·0119 in that from the cod. This method was, however, unsatisfactory, inasmuch as small blood-vessels were cut in slitting up the tissues, and the fluid sometimes possessed a faint sanguineous tinge; the microscope also showed the presence of a few yolk spherules from ruptured eggs. I therefore adopted the method employed by Hensen, and in the case of the plaice by draining 517 cubic centimetres of eggs and fluid from ripe fish through silk netting the quantity of fluid separated was 51·5 cubic centimetres; but a considerable amount of course remained adherent to the eggs. The fresh ovarian fluid of the plaice was handed to Dr. Milroy, who found that it had a specific gravity of 1·0116, as determined by the piknometer, with a neutral reaction, that it was very pale yellow, almost transparent, and contained a large amount of chlorides, phosphates being absent. The amount of chloride of sodium present was 0·766 gramme to each 100 cubic centimetres of the fluid, and the total of the albumins was 0·838 gramme. More recently Dr. Milroy has examined other specimens of the fluid from the ovaries of Teleosteans, which will be found described at p. 135 of this Report.

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* Hammarsten. Lehrbuch der Physiologischen Chemie. 1895.

† *Vierter Berich. d. Kom. z. Wiss. Untersach. d. deutschen Meere.* 1884.

The relation of the free ovarian fluid to the processes of maturation is discussed later (p. 118).

THE OVARIAN DEVELOPMENT OF THE EGGS.

As previously stated, I have investigated the ovarian development and maturation of the eggs of a number of Teleosteans, belonging for the most part to the group in which the mature egg is pelagic. The investigation was made partly on fresh ovaries examined in ovarian succus or in weak salt solutions, much being learned by graduated compression of the eggs; and partly by means of sections hardened chiefly in picro-sulphuric acid or Perennyi's fluid and spirit, and stained for the most part with hæmatoxylin, eosin, and saffranin, and with borax carmine.

It has already been stated that examination of the ovary during the spawning season reveals the presence of eggs in various stages of development. Observers have differed somewhat in the classification of the smaller eggs, but a convenient division of those found in the ovary of a species in which they are pelagic may be stated as follows:—(1) The fully mature, large, free, transparent eggs in which the germinal matter has separated from the deutoplasm and forms a cortical layer enclosing it; (2) smaller opaque eggs, still contained within the follicle, with a relatively thick egg-membrane, distinct yolk-spherules and germinal vesicle; (3) small transparent eggs which exhibit a conspicuous spherical or ovate nucleus with a mantle of protoplasm, and which are destitute of yolk. This classification does not include the minute ova as they arise from the germ cells, but it comprises all those from the period when they can be distinctly recognised as possessing a nucleus and a protoplasmic layer to the time when they are ready for extrusion and fertilisation. In some species there is no sharp line of demarcation between the second and third stages so far as size is concerned—that is to say, one may trace a pretty regular gradation from the small yolkless eggs to the largest yolked eggs, as in the whiting and gurnard; in most other forms the demarcation between the yolkless and the yolked eggs is marked as maturity is approached. As already indicated, these conditions are associated with the length of the spawning season.

In dealing with the growth of the intra-ovarian eggs, I shall not deal at any length here with the earlier stages before the deposition of yolk begins. My observations agree on the whole with those of Scharff* and, especially, Cunningham.† The smallest eggs were found in the ovary of a haddock (caught on 15th August) along the margin of the lamellæ, at their distal ends, or forming digital ingrowths into the stroma. (Plate I., Figs. 1, 2.) In some cases they resembled polynucleated masses, hundreds of minute eggs, measuring from about 0·014mm., being crowded together, with an extremely thin layer of protoplasm between. At this stage the nucleus contains numerous small nucleoli, not arranged around the periphery, but scattered irregularly throughout its substance, and subequal in size; a coarse network can also be seen, and some of the nucleoli at least are obviously of the nature of net-knots or karyosomes. In eggs a little larger, ranging about 0·035mm., the nucleus is surrounded by a zone of coarsely granular protoplasm which stains very deeply; it contains numerous highly-stained nucleoli, one or more of which may be, but is not always, larger than the others; and there is a tendency for the nucleoli to be disposed peripherally. This condition was found in the haddock, whiting, lemon sole, plaice, gurnard, common dab, and eel. In the last the presence of usually one, but sometimes two or three very large nucleoli, highly stained and refringent, is obvious (Fig. 6, Pl. I.); for example, in an ovum measuring 0·08mm., the germinal vesicle of which had a diameter of 0·043mm., the germinal spot measured 0·020mm. In the lemon sole two or three similar large nucleoli were sometimes present, but much smaller relatively than in the eel. In the John Dory (*Zeus faber*) there are also present one or two large refringent highly-stained nucleoli, containing a still brighter point or granule in the interior. In sections of the ovary of a sole containing mature eggs, and stained with hæmatoxylin, saffranin, and eosin, the small ova, measuring about 0·8mm., had in many cases two, and sometimes three, nucleoli larger than the others. In this preparation the intra-nuclear network is well seen, its appearance under a high power indicating a coarse network with large meshes extending equally throughout the nucleus.

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* Quart. Journ. Micr. Sci., Vol. xxviii., p. 53. 1888.

† Ibid., Vol. xl., p. 101. 1897.

In eggs a little larger, from about 0·09 to 0·18mm., a marked feature is the very general disposition of the nucleoli around the periphery of the germinal vesicle, which has at this time a distinct membrane, smooth and regular in outline. It is also relatively large, and its sharp, distinct contour suggests a swollen condition. In the sections of the ovary of an immature haddock, caught in July, which was hardened in picro-sulphuric acid, the ova range in size from 0·08 to 0·16mm., and possess the following characters:—The germinal vesicle is relatively very large, and may measure as much as 0·11mm. in an ovum of the largest size stated. It is spherical, has a definite, quite smooth, regular contour, and the contents, which have not shrunk from the membrane at any part, are greyish and unstained, and under a high power show a finely granular appearance. The nucleoli are subequal in size, and are disposed at fairly regular intervals in close contact with the nuclear membrane, and frequently flattened against it; they number from six or seven to over twenty in a section, and are relatively very small compared with the germinal vesicle. The protoplasm around the latter is highly stained, and shows the usual granular or reticulated appearance, and yolk granules are absent. In the ovaries of an immature common dab, caught on 2nd August, and presenting much the same general appearance, the ova reached a size of 0·162mm. The germinal vesicle and nucleoli resembled those of the haddock, but among the larger eggs the outline of the former was less sharp and pronounced, and was somewhat wavy or irregular, and at certain points towards the periphery yolk-granules were present. In the ovaries of a gurnard, caught on 10th October, and in which degenerating eggs were present, the ova at this stage showed the granular zone sharply marked off. In the haddock previously referred to, which was caught in August and had previously spawned, a narrow granular zone at the periphery was evident in eggs 0·19mm. in diameter, and the germinal vesicle and nucleoli had the same character and disposition as in the immature haddock. In an immature whiting, caught in July, the largest eggs measured 0·13mm.; the germinal vesicle was large and sharply defined, the nucleoli peripheral, and no yolk-granules were present. In the ovaries of a plaice, caught on 20th September, in which the large yolked eggs for the next spawning reached about 0·58 mm., and made up the great mass of the organ, the smaller eggs showed the same condition of the germinal vesicle, the nucleoli being disposed around the margin in close apposition to the membrane.

I have stated that I examined large numbers of the eggs in the fresh condition, and I may here describe the appearance of some of the smaller ones. In specimens corresponding to the sizes I have been dealing with, the germinal vesicle is very prominent, and the nucleoli conspicuous as highly refringent faintly greenish bodies, appearing rather larger than in mounted sections. In some cases in which the nucleus was isolated, its surface was knobbed by the projecting nucleoli. The features were most carefully studied in the eggs of the Norwegian topknot (*Zeugopterus norvegicus*), caught on 25th April. In an egg measuring 0·06mm., and magnified 360 diameters, only one nucleolus was observed, which was very large and conspicuous, and on focussing downwards it presented optical alternations of light and shade suggesting an irregular pyramidal form. Near the nucleus were two bright points, probably droplets of oil. In eggs somewhat larger (0·13 to 0·16mm.) the cytoplasm showed very distinctly the division into two zones described by Ransom,[*] Scharff,[†] Bambeke,[‡] and others, the inner zone being darker and exhibiting a coarsely reticulated structure, and the outer zone lighter, with a fainter reticulated appearance. The intranuclear network is visible, and around the nucleus in the inner zone several bright points are present, which are probably oil. In eggs still larger, measuring from about 0·19mm., the inner zone is seen to be occupied by a great number of minute refringent globules, which are also scattered over the surface of the germinal vesicle. At earlier stages the appearance of the ovum does not specially indicate, in these fresh specimens, a spherical form; but now this is a marked feature, the germinal vesicle, which is large, measuring sometimes half the diameter, stands out boldly as a translucent globe encompassed by a gradually darkening ring, which obscures its periphery and shades off into the lighter area towards the margin of the egg. The dark part of the ring may measure about 0·02mm. This condition becomes more obvious in larger eggs, the germinal vesicle becoming quite obscured by the prominent globules, which are obviously of an oily nature, and vary considerably in size.

On examining a section from the same ovary (which contained fully mature eggs), hardened in picro-sulphuric acid, and stained with hæmatoxylin, saffranin, and eosin, the minute ova, about 0·06mm., show the usual highly-stained protoplasm around the nucleus, but I was unable to detect the large conspicuous nucleolus seen in the fresh egg. The nucleus under a high magnification (Zeiss, 4mm. apochr. oc. 12) shows a coarse intra-nuclear network with a finely granular lighter matrix; nucleoli are by no means conspicuous, and are difficult to discriminate from nodes in the network. In larger eggs, from about 0·16 mm., the cytoplasm around the germinal vesicle was vacuolated, empty spaces of very various sizes existing in the protoplasm. The vacuolation in those in which it is least marked is not quite in contact with the germinal vesicle, but a slight distance from it; but in eggs a little larger it is close up to it, and extends for some distance into the cytoplasm.

This condition is due to the early formation of oil-globules in the peri-nuclear zone. It has been described in the eggs of the eel by Owsiannikow[§] and Williamson,[‖] in those of *Fierasfer* by Emery,[¶] and most fully by Cunningham[**] in the eggs of the gurnard, brill, turbot, and sole. I have also found the condition present in the species mentioned by Cunningham, in the eel, and in the fresh eggs of the angler, the John Dory, the red gurnard, the ling, the catfish, and the topknot, while in sections of the grey gurnard, red gurnard, dory, cat-fish, topknot, and eel the germinal vesicle is surrounded by a zone of vacuoles. Cunningham has shown that the vacuolated condition in mounted sections is owing to the oily matter having been dissolved in the process of preparation; and he also states that the condition above described is characteristic of eggs which possess one or more oil-globules when mature, a conclusion at which I had also arrived.* It is a very conspicuous feature in the smaller fresh eggs of the catfish (*Anarrhichas*), in which, on slight pressure under the cover-glass, the germinal vesicle is seen with a low power to be encircled by a narrow, very dark, almost black, well-defined ring, and in sections the vacuolated appearance is well seen. The condition in the young fresh eggs of the angler is shown in Fig. 10, Plate II., but it will be noticed that in sections of the larger eggs the peri-nuclear vacuolation is not at all obvious. The formation of the oil-globules in the young eggs of the John Dory is represented in Fig. 2, Plate III., and the vacuolation in the older eggs in Figs. 10, 11. Sections prepared from an immature ovary of the angler, hardened in platino-osmic mixture, imbedded in paraffin, and mounted in Canada balsam, still retain traces of the blackened oil.

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[*] Op. cit. [†] Op. cit. [‡] Arch. de Biologie, xiii., p. 88. 1893.

[§] *Mem. l'Acad. Imper. des Sci. de St. Petersburg, vii. ser., Tome xxxiii., No. 4, p. 28. 1885.*

[‖] *Thirteenth Annual Report Fishery Board for Scotland, Part iii., p. 192.* [¶] Op. cit.

[**] Quart. Journ. Micr. Sci., Vol. xl., p. 101.

The oil-globules around the germinal vesicle in the fresh egg, or the vacuolated condition in the mounted sections, is absent in the following species:—Plaice, common dab, long rough dab, lemon dab, witch, haddock, whiting, bib, flounder, halibut, and saithe—and the mature egg in all these species is destitute of an oil globule. It would thus appear that the examination of the immature ovarian eggs of a species is sufficient to indicate the presence or absence of an oil-globule in the mature egg. The early formation of oily droplets in the cytoplasm around the germinal vesicle, before the yolk deposition commences in the periphery, is of interest. It is probable that the chemical relationship between the protoplasm and the oleaginous matter is closer than that between the protoplasm and the more highly differentiated yolk-spherules. In the retrogressive changes which occur in the protoplasm of the mature egg after death, an early feature is the formation of oily-looking droplets. The oil-globules flow together when the watery fluid enters at maturation, to form usually a single sphere. They have no relation to the floating of the egg, and they probably represent a food substance which is present in another form in the eggs of allied species which do not possess an oil-globule.

The next feature in the growth of the egg is the formation of the yolk, which begins to appear as a peripheral zone of granules in eggs of about 0·2mm., the size varying a little in the eggs of different species. As the egg grows in size the yolk-spherules become more distinct, and their formation extends inwards to the wall of the germinal vesicle in those forms which do not possess a peri-nuclear zone of oil-globules. In species whose eggs are pelagic the constitution of the yolk-spherules appears to be essentially similar, so far as their microscopic appearance is concerned. They are of very different sizes in the same egg, and may range from about 0·02mm. in diameter in the large eggs of the plaice down to extremely minute granules. The larger spheres appear to be vesicular, with finely granular fluid contents; some, however, appear quite clear, and may possibly be of an oily nature. If the spherules be treated with dilute acetic acid the contents rapidly flow together into minute vesicles, which coalesce, the granules dissolving and becoming invisible, while the spherule is indicated by an optical ring which unites with other rings in contact with it. A 5 per cent. solution of acetic acid dissolves the contents instantaneously.

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* The presence of numerous peri-nuclear oil-globules in the ovarian egg of the common eel points to the existence of one or more oil-globules in the mature egg. It would therefore appear that Grassi's identification of Raffaele's undetermined species No. 10, which is devoid of oil-globules, with *Anguilla vulgaris*, is very doubtful. (*Vide Quart. Journ. Micr. Sci., Vol.* 39, *Part* 3, *p.* 382.)

In species with demersal eggs the yolk-spherules are both larger and of somewhat different character, being much more solid and granular. In the eggs of the angler they may reach a size of 0·08mm., and they are markedly granular in character. In spirit specimens under a high power the spherules appear to be full of solid-looking refringent spheres with an irregular margin, which sometimes appear as angular crystalline bodies of high refrangibility. In the egg of the John Dory the larger spherules may measure 0·05 in sections, and they are full of very dark granules in the fresh state and exhibit an irregular margin. In sections the spherules take on a deep stain, and appear as conspicuous aggregations or concretions of smaller spherules, so that they have a mulberry-like appearance (Fig. 11^{a}, Pl. III.). This difference in the character of yolk-spherules in pelagic and some demersal eggs is shown in other ways. Thus, the yolk in the latter is, as a whole, much more resistant to pressure, and after hardening it is difficult to cut.

As the formation of yolk proceeds, the protoplasm diminishes in amount, and ultimately it is represented by a delicate film between the spherules, which collectively looks like a network in sections, stains comparatively slightly, and is continuous with the cortical layer externally, and with the wall of the germinal vesicle internally. This interstitial protoplasm between the spherules is in much greater abundance in demersal than in pelagic eggs. The largest spherules, as a rule, are situated about midway between the germinal vesicle and the zona radiata—that is to say, in the zone where they are first formed—and it is obvious that each spherule grows by additions to its substance. With a high power a thin double contour may be made out in certain sections, from which the granular contents have retracted (Fig. 4, Pl. III.).

In the course of the examination of my sections I endeavoured to ascertain the presence of a yolk nucleus, or of chromatic substance, in the cytoplasm, such as have been described in the eggs of Teleosteans by many observers. In many young ova examined in the fresh condition I detected occasionally a highly refringent granule in the cytoplasm, having a faintly greenish hue like the nucleoli in the fresh state, but it may have been a particle of another nature. In sections of ovaries of fishes with pelagic eggs the yolk nucleus is not commonly seen, but two conditions were occasionally found in the cytoplasm of eggs in which the yolk had either not begun to form, or where it was represented by a narrow peripheral zone. In some cases a minute highly-stained body, not larger than a nucleolus, was present, the protoplasm around it not being vacuolated or differentiated. In other cases the condition was different, the yolk nucleus being surrounded by a clear zone, and sometimes irregularly shaped or stellate, the rays passing into the protoplasm, and being apparently continuous with the reticulum. In none of my sections is the vitelline body so common or conspicuous as in those of *Lophius* (Fig. 12, Pl. II.). The origin and function of the vitelline nucleus in the cytoplasm of young eggs are of much interest. Bambeke has described the elimination of chromatic substance from the eggs of *Scorpæna*, and has discussed the various interpretations that have been assigned to the presence of such bodies in the cytoplasm.[*] He represents in a series of figures the appearances he found in sections of the young eggs, which show in most cases the eliminated chromatic substance in the form of threads connected with the chromatin within the germinal vesicle. He had previously given an account of the vitelline body in the demersal eggs of several species.[†] In 1893 Henneguy[‡] described the occurrence of the vitelline nucleus in the eggs of a number of osseous fishes belonging chiefly to the demersal group, especially in *Syngnathus*, and in the following year Hubbard described it carefully in the eggs of a viviparous American fish *(Cymatogaster)*, in which he found that it continued until the closure of the blastopore.[§] More recently Cunningham has given an account of its presence in teleostean eggs.[‖] The true function of the vitelline nucleus has been much discussed. Two things are significant in connection with its appearance in the cytoplasm. One is the fact that it precedes the formation of yolk-granules in the peripheral zone to which it moves. The other is the fact that it is more commonly to be observed in demersal eggs, in which the yolk is more concentrated, than in pelagic eggs, and that then more than one may exist.

Some observations which I have recently made, most fully on the eggs of the angler and John Dory, are of some interest in connection with the elimination of chromatic substance from the germinal vesicle. They may be given here, although I have been unable, for want of time, to make drawings illustrating all the points described, which I hope to do later.

In *Lophius*, as elsewhere described (page 125), the minute ova are to be found at the base of the ovigerous pouches. In sections of the ovary of a specimen caught on 5th March, hardened in platino-aceto-osmic mixture and stained with hæmatoxylin, saffranin, and eosin, and in which the largest eggs in a pouch measure about 0·109mm., the most minute eggs at the base measure about 0·0056mm. They are not much larger than the rounded cells seen in the epithelial layer, which measure from 0·0035 to 0·0042mm., and they present precisely the same appearance when examined with Zeiss' 2mm. oil-immersion and compensating ocular 6; that is to say, they are clear vesicles, with a minute but conspicuous, brilliantly stained (red) spherical nucleolus placed in the centre, or somewhat excentrically, a scanty network that cannot be well seen, and no protoplasm around. In those a little larger, measuring about 0·007mm., the nucleolus measured 0·0018mm., and the network could be more distinctly traced in the form of a few, relatively thick, granular threads radiating from the nucleolus and showing at points slight thickenings of the nature of karyosomes. The threads are very few compared with later stages, and they are also thicker; from three or four to about a dozen may be seen passing from the nucleolus, sometimes in a radial manner, like the spoke of a wheel; and on focussing the periphery the thickenings appear as dots radially disposed around it. There is still no cytoplasm.

In eggs a little larger, measuring about 0·0098mm., the network is seen to have considerably increased, but the meshes are still wide; the prominent nucleolus has disappeared, and in its place numerous more minute, red-stained karyosomes are to be observed at intervals throughout the network; the condition suggests that the nucleolus has melted or become diffused. In eggs a little larger, from about 0·011mm., a very delicate, filmy-looking layer of protoplasm may be detected outside the germinal vesicle. In the great majority of cases this is aggregated at one side of the germinal vesicle, or rather at one end, for it is usually now somewhat ovate. The network has still further increased in abundance, the threads, however, are more slender and not so coarse-looking; there are numerous minute karyosomes, and in some cases a few small nucleoli can be seen at the periphery, in the position and with the appearance of those which are always afterwards so conspicuous in the teleostean egg.

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[*] Elimination d'éléments nucléaires dans l'œuf ovarien de *Scorpæna scrofa*.—*Arch. de Biol.* xiii., p. 88. 1893.

[†] *Bull. Acad. des Roy. Sci. Bruxelles*, 3 Ser., Tom. vi., p. 843. 1888.

[‡] *Jour. de l'Anat. et de la Physiol.*, *N.S.*, Vol. xxix., p. 1. 1893.

[§] *Proc. Amer. Phil. Soc.*, xxxiii., p. 74. 1894.

[‖] Op. cit.

But the most striking feature about the eggs is the presence in the primitive cytoplasm of brightly-stained granules, presenting precisely the same appearance as the nucleoli within the germinal vesicle. I was at first puzzled by them; an egg would appear a little larger than those of which I have been speaking, with a number of what appeared to be nucleoli lying free around it, the cytoplasm itself being scarcely visible. I was able to trace this condition through whole series of eggs up to those 0·03mm. in diameter, and to trace the presence of a multitude of stained particles in eggs very much larger. For example, in an egg measuring 0·021mm. by 0·0126mm. the cytoplasm was aggregated at one end in a layer 0·006mm. thick, slightly stained, and chiefly with hæmatoxylin, and it contained a large number—between thirty and forty in the section —of bright red granules exactly similar in size and appearance to the nucleoli. The germinal vesicle contained the network described, more abundant than in the smaller eggs, far less so than in those of larger size, with numerous minute karyosomes, and with seven or eight small nucleoli, mostly aggregated at the end where the cytoplasm was. In another egg, measuring 0·03mm. by 0·024mm., the cytoplasm was also chiefly collected at one end, but formed a distinct layer all around the germinal vesicle, which measured 0·0196mm. by 0·0168mm.; the small follicular cells were becoming flattened against, and attached to, the periphery. The germinal vesicle, compared with the cytoplasm and previous stages, was markedly achromatic and clear; the network had increased in abundance, and was formed of fine granulated threads with minute karyosomes, and with a few very small inconspicuous nucleoli at the periphery. The cytoplasm was pretty deeply stained bluish purple; and it contained a large number of the brightly-stained red granules, now somewhat irregular in shape, and uniformly distributed throughout it; there were also present two or three intensely black points—oil droplets which had been blackened by the osmic acid. In some eggs about this size, and in those a little larger, the network within the germinal vesicle appeared to be differentiated into two classes of threads, finely granular and rather coarser with thickenings; or it may be merely that the aggregation of chromatin granules on some of the threads was greater than on others.

In larger eggs, measuring about 0·09mm., with the germinal vesicle about 0·047mm., the network of granular threads has increased in amount, and the nucleoli are more conspicuous than in the earlier stages. Towards the centre of the vesicle there are more marked fibrils indistinctly seen to be composed of stained granules as in the later stages described below, and also minute free chromatic granules in the neighbourhood. The appearance of the cytoplasm is interesting. The chromatic granules present in it are exceedingly numerous—several hundreds may be seen in a section of such an egg. Around the germinal vesicle there is a layer of them, and they also tend to be aggregated at the periphery of the cytoplasm, but throughout the whole of it they exist in numerous pockets, clusters, and strings. The intervening portions of cytoplasm are very finely granular and stained purplish, while the granules themselves are red, but not the brilliant red of the earlier stages; the spaces between the granules, and in a cluster immediately around them, are clear and unstained, suggesting either shrinkage, or more probably fluid that does not stain. These chromatic particles may be more or less rounded in form, or, usually, somewhat angular or irregular, and their size varies considerably. The larger measure about 0·001mm., but most of them are under 0.5μ; those around the germinal vesicle are small. They are coarser in the smaller eggs. This condition of the cytoplasm is very well shown in the small eggs in sections of an ovary containing nearly ripe eggs preserved in picro-sulphuric acid, and stained with eosin, rubin, and orange. The germinal vesicle shows the usual granular network, the nucleoli are flattened against its wall and are stained dark indigo blue, and throughout the cytoplasm, here shown finely reticular, are hundreds of rounded granules of various sizes stained precisely like the nucleoli.

For example, in an egg in this section, measuring 0·126mm. by 0·098mm., the germinal vesicle measuring 0·042mm. by 0·049mm., the nucleoli were about a dozen in number, ranging from about 0·002 to 0·0035mm., and all flattened against the membrane. In the germinal vesicle, distinctly visible in the rather achromatic network, was a coil of minute chromatic granules, the coil being 0·0112mm. in breadth, and free chromatic granules lay close to it. The whole of the finely reticulated cytoplasm was charged with minute, conspicuous granules, stained very dark like the nucleoli, and of various sizes, the largest measuring about 0·0018mm. Lying close around the germinal vesicle, the section of whose membrane was very distinct but very thin, there were many of the granules of the larger sizes, sometimes in little clusters; but they were not limited to this position. At the periphery of the cytoplasm at one part, where the zona was not in contact with it, the stained granules could be well seen sticking to the somewhat flocculent-looking ground substance.

I was also able to trace the formation of the yolk-nuclei in some of the eggs. I have already said that these bodies are very common in sections of young eggs of the angler towards the periphery, and at the stage represented in Fig. 12, Pl. II., when examined with high powers, they appear rather as condensations of the cytoplasmic substance, with an indefinite, diffuse, woolly-looking margin. In some of the smaller eggs above described, I found that they were composed of a nest of chromatic granules, formed either near or far from the germinal vesicle indifferently, and I found various stages, from an aggregation of distinct granules to an irregular ball, in which indication of the components could only be made out with a high magnification. The yolk-nuclei in these cases are formed by the coalescence of chromatic particles.

In sections of the ovary of a John Dory, fifteen inches long, caught on 22d July, preserved in picro-sulphuric acid, and stained with eosin, saffranin, and hæmatoxylin, the same conditions were observed:--Minute ova, with a single bright nucleolus and scanty coarse network, sometimes stellate, and no cytoplasm; larger, with a more abundant network, nucleoli and karyosomes, and the primitive cytoplasm charged with chromatic particles; and in those somewhat larger, the presence of more prominent granular fibrils in the germinal vesicle. But in the dory the nucleoli are relatively larger and more numerous, and the primitive chromatic cytoplasm is pushed outwards by the growth of more finely granular less stained cytoplasm around the germinal vesicle, so that it forms a deeply-stained ring at the periphery of the egg. It is in this that yolk formation begins. In sections of the ripe ovaries of the herring (caught on 28th January, and preserved in the same way), the smaller eggs showed the same condition as in the dory. For example, an egg 0·07mm., with a germinal vesicle 0·042mm., showed a very highly-stained peri-nuclear zone, a large number of very prominent nucleoli attached to the membrane, and a network containing fibrils with chromatic granules attached, and free granules, some as large as the smallest of the nucleoli, lying near them.

The same condition of the primitive peri-nuclear protoplasm has been observed in the small eggs of the catfish, solenette, sole, plaice, *Zeugopterus* and *Gadus luscus.*

In the eggs of the dory which have reached the size and condition of the specimen shown in Fig. 10, Plate III., and in which yolk is formed, the appearance of the germinal vesicle shows that the process of differentiation has gone a stage further. The germinal vesicle of such an egg, measuring 0·013mm. by 0·009mm., is shown in Fig. 14, and it will be observed that the nucleoli are large, deeply stained, numerous, and nearly all peripheral. Scattered throughout its whole substance, which appears somewhat dense and finely granular, there are a large number of free, spherical, brightly-stained granules. The largest of these measured scarcely 0·002mm. (while the smallest "nucleoli" measured 0·004mm.), and the great majority measured less than 0·0005mm. These free granules resemble closely the chromatic granules in the primitive peri-nuclear protoplasm of young eggs.

The most striking feature, however, is the presence of quite distinct coils or loops of chromatic, spherical, equal-sized granules, or chromosomes, placed near the centre of the germinal vesicle. Whether, in the complete form, it is arranged as a spireme or in scattered loops and chains, I cannot say. The granules in appearance and staining are precisely similar to the smaller free granules in the karyoplasm. The area occupied by the coil is about 0·05mm. in diameter. The convexity of the loops is, as a rule, towards the periphery. The longest chain that could be traced continuously measured 0·024mm.; it was composed of about 25 granules; with one or two slight interruptions, where it was possibly cut through, it could be traced for a distance of about 0·07mm. The larger of the free granules, with a few nucleoli, were chiefly aggregated in this area. The chromosomes are not at all feathery, as Cunningham has described in some forms, but distinctly moniliform. The karyoplasm in the neighbourhood of the chromosomes is clearer than elsewhere.

In somewhat smaller eggs (Fig. 9, Plate III.) the mass of the germinal vesicle is made up of a reticulum of finely granular threads, but in various parts throughout it more coarsely granular threads can be seen, and here and there a chain of four or five larger granules exists. Free stained granules are also dispersed throughout the karyoplasm, and some minute nucleoli may be present towards the centre.

In eggs about 0·11mm. the same condition is shown; the moniliform threads can only be distinguished from the granular (linin) threads by somewhat greater size and conspicuousness, and they appear to be in the form rather of a branching reticulum than in loops or coils. Free granules are also present. In eggs still smaller the moniliform threads cannot well be distinguished from the granular threads.

What is the interpretation to be placed upon the phenomena I have described? It is, I think, clear that chromatic substance is manufactured in large quantities in the germinal vesicle, and that it passes out into the cytoplasm. In the young eggs of the angler the primitive single nucleolus appears to liquefy and to become diffused along the threads of the scanty network to form karyosomes; many of these, as they increase in size, become free nucleoli flattened against the vesicular membrane, and a very great deal of chromatic substance passes out into the cytoplasm, which at first consists largely of chromatic particles. There appears, in short, to be an exodus of chromatic granules into the perinuclear zone, and the function of this elimination of chromatin must surely be in connection with the formation of yolk. The primitive ovum has two chief functions—to preserve the chromatin of heredity, and to produce the cytoplasm, in which the yolk is the chief constituent. The amount of chromatic substance present in the germinal vesicle is far greater than what is required for the egg-nucleus and the polar bodies. The eliminated chromatin does not come from the nucleoli, unless, possibly, but not probably, in the primitive eggs. I have seen nothing to indicate a "budding" from nucleoli, or from the germinal vesicle, as some observers have described; nor anything resembling a fusion or division of nucleoli. The nucleoli seem to grow as independent bodies from chromatic "granules"; whether or not also by fusion of minute granules, I cannot say. At the close of the growth of the ovum we shall see that they break up into a large number of chromatic granules.

It seems to me that, as the egg grows in size, the manufacture of chromatin is chiefly restricted to a certain part of the reticulum, at or near the centre of the germinal vesicle, namely, at the loops described, and that the particles formed move outwards, some probably to form nucleoli, others to pass into the cytoplasm. At the close of ovarian growth the chromosome loops or spireme is very much smaller, and not more highly stained (Fig. 7, Plate III.).

THE LARGE OPAQUE EGGS.

I now proceed to consider the large opaque eggs shortly before they undergo the translucent enlargement at maturation and acquire the peculiar characters that distinguish the ripe pelagic ovum. Large numbers belonging to various species were examined in the fresh state, and also in stained and mounted sections. The egg-membrane, or so-called zona radiata, when freed from its follicular investment, presents much the same character in them all, consisting of a clear translucent layer that varies in thickness in different species. In demersal eggs it is generally thick and tough, usually of two or more layers, and it may possess tubercles and other processes on its external surface. It is very thin in the flounder and dab, and much thicker in the plaice and cod. Up to the period of maturation the egg-membrane appears to increase in thickness with the growth of the egg, but measurements in mounted sections cannot always be trusted owing to the fact that re-agents act upon it, and may alter it considerably. The addition of a 5 per cent. solution of acetic acid swells up the egg-membrane instantaneously, and softens it so much that the contents break through; a strong solution of common salt acts in the same way, but much more slowly. The membrane of plaice eggs may swell to a thickness of 0·2mm.—many times more than the normal thickness—in a short time.

The egg-membrane may present differences in markings as well as differences of thickness in various species. The markings are usually of two kinds, both of which are generally found together. One consists in the very common presence of wrinkles or creases, which exhibit anastomosing or convoluted irregular ramifications on surface view, and can be shown by careful focussing to be elevations or depressions in the substance. The second condition consists of very minute dotting or punctation, which may be arranged in more or less radial lines. In the mature egg of the plaice I have found this dotted pattern to be limited to an extremely thin superficial pellicle, which may spontaneously separate from the outer surface of the zona radiata as a delicate lamella in specimens which have been softened in water. I have also observed it sometimes in carefully rupturing the large mature living eggs, by pressure, as a thin lamina pushed out in lenticular fashion by the yolk oozing from the rupture in the subjacent membrane, and gradually stripped from the latter as the escaped yolk increased in quantity. This superficial pellicle probably represents a membrane upon which the pavement of follicular cells rests, and the minute dots may possibly be due to depressions caused by the follicular cells. They are certainly not, what some observers have apparently thought, the outer openings of radial canals; although in optical section, with moderate powers, the presence of these minute dots arranged in lines may simulate fine striations passing through the zona radiata.

The structure of the egg-membrane proper, the so-called zona radiata, has been much discussed. For reasons which will shortly be given, it appears that in the substance of the zona of pelagic eggs numerous creases or plications exist. In the opaque egg, before the mechanical expansion at maturation takes place, the sides of these plications or creases are in contact, but when the egg becomes distended to three or four times its previous size, they are stretched and separated, in much the same fashion as occurs in the expansion of the walls of a concertina when it is drawn out; in the egg, however, the plications are irregular. The question of whether the zona possesses fine pores or radial canals has been much disputed, but it is unnecessary to enter into the discussion here; a pretty full discussion of the subject is given by Brock[*] and by Eigenmann.[†] A radial appearance may be frequently seen in the membrane of pelagic eggs examined in optical section, with moderate powers, but in many cases at least it is due to the radial lines of dots described above. In mounted sections of the immature eggs of the sole, lemon sole, gurnard, and solenette, radial striation is obvious (Fig. 7, Pl. I.), but in most species it cannot be discerned, although a fibrillated appearance is not uncommon. The existence of radial porous canals in the zona of pelagic eggs appears to me to be unproved, although many facts show that the membrane, like other animal membranes, is porous.

The question whether there is more than one layer in the egg-membrane of pelagic eggs has also been disputed, although most observers are agreed that there is not. In demersal eggs two or more layers usually exist (Figs. 16, 17, Pl. I.; Figs. 10, 11, Pl. III.). Sars described several lamellæ as existing in the capsule of the cod's egg,[‡] but he has not been followed in this opinion. The superficial lamella in the egg of the plaice has been referred to, and it probably is present in the eggs of other species in which the dotted pattern exists; but this condition is of little importance, although it may be the homologue of the outermost of the two layers of demersal eggs. But there is another membrane normally present, I believe, in both pelagic and demersal eggs, which is no doubt of functional importance. I refer to an extremely delicate membrane which encloses the vitellus, and which clothes it after the formation of the perivitelline space, and therefore separates it from the perivitelline fluid. Such a vitelline membrane has been described by several observers, though its existence is usually denied. Ransom mentions it in the egg of the stickleback as "a delicate, colourless, translucent, homogeneous membrane," which he called the "inner yolk-sac," his "outer yolk-sac" being what is usually known as the zona radiata.[§] It has also been described by Vogt in the eggs of *Coregonus** by Oellacher in the eggs of the trout,† and by others. Among pelagic eggs, Scharff found it in sections of the gurnard ‡, but only in the young eggs, and Calderwood has described it in a section of the egg of the sole.§ Eigenmann || thinks its existence to be unproved.

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[*] *Morph. Jahrb.* iv., *p. 505. 1878.*

[†] *Bull. Mus. Comp. Zool. Harv. Col.* Vol. xix., No. 2, p. 129. 1890.

[‡] Op. cit.

[§] *Phil. Trans. Roy. Soc., London.* Vol. 157, p. 431. 1868.

I am able to affirm its existence in the eggs of *Gadus æglefinus*, *G. virens*, and *Pleuronectes flesus*. In dealing with fresh (opaque) eggs under pressure it was sometimes revealed as a delicate pellicle projecting from a rupture in the capsule, bounding and retaining the protruding yolk (Fig. 8, Pl. I.), and then bursting and emitting the yolk with a rush on the slightest increase of pressure. At other times, on diminishing the pressure, the yolk would be partially sucked back within the egg, and the walls of the protruding membrane were then well observed (Fig. 9, Pl. I.). In certain other cases it could be seen within the zona when the yolk had separated from the latter (Fig. 10). Usually it was ruptured with the zona radiata and not distinguished. I have not been able to satisfy myself of its presence in mounted sections. It is not a mere condensation of the surface of the vitellus, at all events morphologically, whatever it may be in origin. Under a high power this membrane appeared to be quite homogeneous, and showed a faint double contour. Its function is no doubt of importance in the mature egg after it has been shed, and the perivitelline space formed between the zona and the vitellus by the imbibition of sea water. It will then intervene between the sea water and the periblast. Probably, although I have no observations on the point, this vitelline membrane is continuous with the inner margin of the micropyle before the formation of the perivitelline space. In the living fertilised egg of the flounder, at an early stage, I was able to trace it, quite distinct from the periblast, up over the edge of the blastodisc, where it was lost on the surface of the latter. In some eggs of the same species after death, when the cortical protoplasm had begun to retract, as it always does in dead eggs, from the zona radiata, the delicate membrane was carried with it and was thrown into wrinkles in the neighbourhood of the blastodisc, the lines converging towards the latter in a radial manner, and sometimes passing over the edge of the blastomeres. I cannot but think that further investigation will show the existence of this membrane in other pelagic eggs. It may best be shown by the patient examination of fresh specimens under pressure.

With regard to the yolk in the large opaque eggs, there is nothing to add to what has been already said. The yolk-spherules form the great bulk of the egg. In fresh specimens under pressure they may be watched escaping with the fluid matrix in which they are imbedded; the application of heat or of hardening agents coagulates this fluid, in which case the spherules are observed to be attached to and imbedded in the granular or flocculent colloid substance. After treatment with strong solution of common salt, the contents come out in a clear, syrupy, coherent stream. As has been said, the interstitial matter in demersal eggs is larger in amount and less fluid that in pelagic eggs.

The germinal vesicle is large and central ; I have never observed it markedly excentric in the pelagic ovum. In the fresh condition it is globular, or it may be somewhat ovate, and smooth, but in sections it usually appears irregular in outline, or even stellate, apparently from

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* Embryologie des Salmones, in Agassiz's Hist. Nat. des poissons d'eau douce de l'Europe centrale. 1842.

† *Zeitschr. f. Wissensch. Zool.* Bd. xxii. 1872.

‡ Op. cit., p. 68.

§ *Journ. Marine Biolog. Assoc.*, New Series, Vol. ii., No. 4, p. 307. 1892.

|| Op. cit.

alteration by the action of the re-agents. In these cases the rays may often be traced passing into the protoplasmic network lying between the yolk-spherules. This is well shown in some sections of the ovary of the plaice, fixed with 5 per cent. solution of nitric acid (Fig. 5, Pl. I.). The nuclear membrane in such cases is frequently indistinct. In preparations hardened with picro-sulphuric acid this appearance is less obvious, owing partly to the shrinking of the nuclear substance. At this stage the nucleoli are not, as a rule, so prominent and highly stained as at an earlier period, and they are usually smaller and less numerous, and for the most part disposed around the margin, although many of them lie towards the centre of the germinal vesicle. In the largest opaque eggs in the ovary of a sole, in which fully mature eggs were also present, the nucleoli numbered from five to twelve in a section, and they were of different sizes. In a germinal vesicle, measuring 0·15mm., the ovum measuring 0·61mm., the largest nucleolus measured 0·006mm. In the ovary of a bib (*Gadus luscus*), preserved like that of the sole in picro-sulphuric acid and containing mature eggs, the nucleoli were much more numerous, numbering frequently over fifty in a section, but they were also smaller. The disposition and appearance of the nucleoli in the egg of the solenette at this stage is shown in Fig. 7, Pl. I.

I was unable to make out satisfactorily the presence of a chromatin network or threads in the germinal vesicle of these advanced pelagic eggs, although it is distinct in the smaller ones lying beside them. With the exception of the very early stages the nucleoli are not of the nature of karyosomes; they lie as distinct more or less spherical bodies in the nuclear substance. Very frequently they exhibit internal differentiation, showing granulation or vacuolation. In the opaque demersal eggs of the John Dory and angler I was able to make out the existence of chromatic elements apart from the nucleoli. The appearance in the dory is shown in Figs. 12, 14, Pl. III., the former of which represents the germinal vesicle of the egg shown in Fig. 11, magnified 260 diameters. It will be observed that the nucleoli are for the most part peripheral, and that in the central part of the germinal vesicle there are numerous minute spherules or granules, not quite so deeply stained as the nucleoli, and arranged more or less in a chain-like series. This condition is found in the germinal vesicle of all the eggs of this size in the section, but the serial arrangement is not always so well seen. In some cases a minute nucleolus exists in the same region, distinguishable from the granules only by its greater size and refrangibility. These eggs of the dory were still evidently far from maturity.

The condition is still better seen in the large opaque eggs of the angler just before the change at maturation. The appearance of the germinal vesicle in the smaller eggs, which are devoid of yolk, is shown in Fig. 6, Pl. III., as seen under Zeiss 2mm. oil-immersion lens, with compensating ocular 4. In the large opaque eggs the nucleoli begin to gather towards the centre of the germinal vesicle, and they are then markedly compound, consisting of aggregations of bright granules, somewhat resembling in optical appearance the yolk-spherules in *Zeus faber* (Fig. 5, Pl. III.). From this preparation, and from another of the nearly mature egg (Fig. 4, Pl. III.), to be described later, it would appear that the nucleoli, towards the close of ovarian growth, disintegrate, the numerous minute granules contained within them being set free. A nucleolus which has undergone this change is represented at *a* in Fig. 5. Compared with the other nucleoli it is very slightly stained; it is flaccid in appearance, devoid of granulation, and with an irregular aperture or cavity; it strongly suggests a husk or capsule. In the neighbourhood will be observed a number of minute stained granules, similar to those within the other nucleoli, and which have doubtless escaped from it. In the central area enclosed by the circle of nucleoli, and which is more translucent than the rest of the germinal vesicle, another appearance is visible. The delicate moniliform linin network will be observed as the morphological basis, and here and there are chains of minute stained granules, arranged in curves which represent the chromatin threads usually described, or chromosomes.

The central area, as has been said, is much more translucent than the rest of the germinal vesicle, the linin network is more loose and open, and the contents no doubt more fluid, and probably the seat of more active chemical changes. The proximity of the ring of disintegrating nucleoli, which move into this position where the chromatic chains are distinct, must be noted; and one is tempted to suggest that the escaped nucleolar granules undergo further metamorphosis to form the chromatic chains. It will be observed in the figure that some of the minute isolated spherules or granules (*b*) are of a different character from the rest, as if they were undergoing granular disintegration; there are also a number of highly-stained granules scattered through the karyoplasm. This explanation agrees with that put forward by Cunningham to account for the absence of nucleoli and the presence of irregular chromatic rod-like bodies, obviously derived from the nucleoli, in the nearly mature ova of the turbot.* But if this view of the fate of the nucleolar contents is correct it will not, I think, apply to all of them, because in the germinal vesicle of the egg of the angler undergoing the hydrolytic change at maturation numerous granules, similar to those described, are to be seen scattered in the substance of the germinal vesicle. Many of these are extremely faint in outline, and appear to be fading or dissolving away (Fig. 4, Pl. III.).

I may here say that my observations on the characters of the germinal vesicle support the opinion of Cunningham—" that the multiplication of " nucleoli in the teleostean ovum, and their disappearance at a later stage, " are effected by the streaming of chromatin along threads of linin." As previously stated, in the germinal vesicle of the minute eggs examined a somewhat coarse, irregular network is readily perceived, with a number of small nucleoli scattered throughout it. These are obviously at this stage karyosomes, and they appear to be due to the collection at the nodes of the network of semi-fluid chromatic substance, in very different amounts, so that the droplets are of various sizes. As they increase in dimensions they either separate from the node or dwarf it. At all events in sections they appear as isolated bodies, and they flow to the periphery at an early stage, and become disposed in apposition to the membrane at fairly regular intervals prior to the formation of yolk or differentiated cytoplasm, a site which they continue to occupy to nearly the close of ovarian growth. At the same time the rest of the germinal vesicle becomes more and more achromatic. The view which has been put forward that the nucleoli are of little importance in the ovum, and may be even regarded as by-products or effete matter resulting from nuclear activity, is, I am sure, inapplicable to the teleostean egg. On the contrary, their number, size, position, and history show that they perform an important rôle in the metabolism of growth, the formation of the cytoplasm, and probably of the yolk. On the hypothesis that the secretion of the follicular cells during the whole period of the growth of the ovum has the same composition as the free ovarian fluid, it is obvious that it must undergo very considerable alterations before it is transformed into the cytoplasm and yolk-spherules. This metabolism no doubt has its centre in the germinal vesicle, and the most prominent objects in the germinal vesicle are the nucleoli, which, as we have seen, move to the periphery, *i.e.* nearest to the cytoplasm, very shortly after cytoplasm begins to be formed. This movement of the nucleoli is comparable to the migration of the germinal vesicle to the seat of growth in growing plant cells.

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* Op. cit., pp. 146, 147, 159.

Some features of the germinal vesicle of the large opaque eggs were also studied in fresh specimens. By graduated compression and rupture of the egg-capsule it was not difficult to isolate the germinal vesicle so as to be able to examine it with medium and moderately high powers, and also to ascertain something concerning its physical properties by watching its behaviour when escaping from the aperture, and under different conditions. Some appearances of this kind are shown in Figs. 11, 12, 13, Pl. I. In the fresh egg of the flounder, taken from the living fish and immediately examined in the ovarian fluid, the germinal vesicle on extrusion appears as a clear, jelly-like, or tenacious, semi-fluid body. It adheres to the outer surface of the egg-membrane, and rolls along it, but clinging to it, in the streams of yolk produced by variations in the pressure on the cover glass. It changes its shape or becomes indented when a stream of yolk impinges against it, but in a slow, flowing fashion, and also in passing between two adjacent eggs on the slide; it is obviously soft, non-elastic, and tenacious. The germinal vesicle of eggs removed from a fish which has been dead for some time does not behave in this way. It has lost its adhesiveness and becomes less soft, but can be readily made to change its shape, and it easily ruptures (which, indeed, very frequently happens as it escapes from the aperture in the zona), and a clear, somewhat syrupy, fluid escapes, to which yolk-spherules become attached. In the opaque eggs of the cod, haddock, and plaice, which had been kept (in January and February) for a day or more, the contents of the isolated germinal vesicle were much more fluid, running out among the yolk-spherules and disappearing. The germinal vesicle measures between one-third and one-fourth of the diameter of the egg. On examination with a moderately high power, delicate fibrillæ could sometimes be detected passing from the surface among the yolk-spherules attached to it (Fig. 18, Pl. I.). The surface also shows distinct but very fine and minute dotting, an appearance probably due to rupture of the protoplasmic threads that pass between the yolk-spherules. Retraction of the contents allowed the membrane to be seen very distinctly; that of a cod's ovum, which contained somewhat watery contents, was left after the latter escaped as a delicate wrinkled film.

The addition of a 1 per cent. solution of acetic acid, or of a 10 per cent. solution of common salt, clears up the yolk, and darkens and renders visible the germinal vesicle; the salt solution acts more slowly. The ordinary opaque eggs left to soak in a 1 per cent. solution of common salt for some hours clear up imperfectly, but sufficient to allow the germinal vesicle to be seen as a translucent area in the centre. These re-agents reveal the dark peri-nuclear ring of oil-globules in those eggs which possess it; but after a little the globules collect for the most part towards the surface of the egg owing to the disintegration of the protoplasmic strands.

The thin cortical layer of protoplasm which everywhere encloses the yolk is continuous with the interstitial protoplasm that passes between the yolk-spherules, and is, as we have seen, separated from the zona radiata, at least in some cases, by a delicate membrane. The cortical layer may be demonstrated in the fresh opaque egg by careful examination of the periphery of the vitellus, especially when it is retracted from the zona radiata (Fig. 10, Pl. I.). It is also well seen in mounted and stained sections (Fig. 7, Pl. I.) as a thin stained layer within the zona. It is the only part of the cytoplasm of the pelagic ovum which retains its position and appearance after the transformation at maturation, when, supplemented by the interstitial protoplasm, it forms the periblast. It can be better studied in fresh eggs than in sections, with respect, at least, to the numerous very minute, bright, shining granules imbedded in it, and which are optically indistinguishable from minute yolk-spherules. The protoplasmic pellicle is itself very thin, measuring in the large opaque ovum of the flounder not more than about 0·015mm., and the granules are crowded together much more closely than in the mature ovum, in which, after fertilisation, they become aggregated in clusters or strings. In the mature eggs of the grey gurnard they measured 0·005mm. They are sub-equal in size and fairly regularly scattered in the protoplasmic pellicle of the mature unfertilised egg, from ten to eighteen being found within a square with a side of 0·10mm. Kupffer called these bodies in the egg of the herring yolk-granules (Dotterkörner). Ryder* and Agassiz and Whitman† applied no special name to them, and their significance and fate are not very clear. They resist dilute acetic acid, and according to Ryder they also resist the action of ether and alcohol, and they do not stain. In mature eggs which have been dead for days they persist unchanged, even after the periblast has greatly shrunken and is partially disintegrated. They are also interesting from the circumstance that, apart from oil-globules when these are present, they are the only definite bodies which can be recognised to remain unchanged within the ovum during the final stage of maturation. The yolk-spherules, germinal vesicle, and nucleoli all vanish, but the cortical layer with its granules persists.

The large opaque pelagic eggs, then, before they begin to undergo the physico-chemical changes at maturation, and while still invested by the follicular epithelium, consist of the following parts :—The egg-membrane or zona radiata, which is (relatively to the mature egg) thick; an extremely delicate membrane within, at least in some cases, which covers, and follows in its retraction, the vitellus; a thin cortical layer of protoplasm with minute shining granules imbedded in it, which is directly continuous with, and may be regarded as a peripheral enlargement of, the protoplasmic meshwork between the yolk spherules and granules; an enormous number of yolk-spherules of very various sizes which compose the great mass of the egg; in many cases oil-globules which are situated around the germinal vesicle; a germinal vesicle of large size, centrally placed, possessing a distinct soft membrane, with which the protoplasmic matrix of the cytoplasm is continuous, and containing numerous more or less spherical nucleoli.

THE MATURE EGG AND THE CHANGES AT MATURATION.

The mature pelagic ovum, as previously stated, has a very different appearance from the opaque eggs of the preceding stage, and its structure, so far as it may be distinguished, is much more simple. In consists of the envelopes described, which are, however, much stretched; the thin cortical layer of germinal protoplasm, with its shining granules, which

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* *U.S. Fish Commis. Report for* 1882, p. 455.

† *Proc. Amer. Acad. Arts and Sci., xii., p.* 23. 1885.

may be aggregated towards one pole to form the blastodisc, and the large globe of colourless homogeneous fluid yolk of crystalline transparency—a drop of clear fluid surrounded by the periblast and envelopes (Fig. 15, Pl. I.). In some cases one or more oil-globules may be present in the fluid yolk; in other cases part or all of the fluid yolk is enclosed in large compartments, that is to say it is divided up into segments by delicate protoplasmic partitions or films as in the eggs of the sole, sprat, pilchard, and anchovy. This condition is produced when part of the interstitial protoplasm between the yolk-spherules remains dipping in from the cortical layer; usually it is transferred to the latter. In all cases the spherules are dissolved and the yolk is fluid. No trace of the germinal vesicle or of the nucleoli can be seen, and although we know from the subsequent history of the fertilised egg that the chromatic substance that goes to form the polar bodies and the egg-nucleus must be present in the germinal layer in the neighbourhood of the micropyle, I have been unable to detect it. Thus practically the whole internal fabric of the egg has dissolved.

That this remarkable change in the pelagic egg at the close of its ovarian growth, by which it becomes fitted for fertilisation and pelagic life, is produced by the entrance of a large quantity of watery fluid will be immediately evident.

The enlargement and translucent appearance of ripe pelagic eggs have long been known, but the fact that the transformation is due to the imbibition of fluid has hitherto escaped the attention of observers. Thus, for example, Ryder,[*] speaking of the eggs of the cod, says:—“Such partly developed ova, when examined with reflected light, “appear whitish instead of a clear, transparent, yellowish tint, such as “would be noticed in ripe eggs. This difference in colour is due to a “change in the character of the plasma enveloping the germinative vesicle, “for immediately that the eggs are mature and ready to leave the intra-“ovarian cavity they acquire a remarkable transparency. This must be “due to a comparatively sudden blending of the protoplasmic corpuscles of “the egg into a homogeneous material very like the white or colourless “albumen of a hen's egg.” Agassiz and Whitman[†] speak of the “yolk “elements having melted together in the form of a homogeneous ball,” and Whitman elsewhere[‡] mentions the “clearing up of a pelagic fish egg “the moment it comes in contact with water, owing to the dissolving of its “opaque granules,” but he is describing what occurs in the fully mature egg after it is shed,[§] and the disappearance of the granules in the periblast. M'Intosh and Prince, in their elaborate memoir on the development of Teleosteans, state that the translucency of the ripe egg “is due to the disappearance of the granules in the yolk of the ovarian egg”;[‖] nor does Raffaele, in his memoir on pelagic eggs, advance any explanation of the change.[¶] Cunningham, in his excellent work on the natural history of marine fishes, mentions the yolk “globules as having run together into one large globe.” He also says, “If the roe of a “spawning fish is examined it is seen that some of the eggs have become “larger and transparent, while a portion of the roe still consists of the “chalk-white smaller eggs. In fact, the eggs become more or less “clear and transparent when they are ripe, and then they become loosened “from the sides of the roe, fall into the cavity, and so make their way to

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[*] Op. cit., p. 69.

[†] *Mem. Mus. Comp. Zool. Harvard College, Vol. xiv. No. I., Part ii., 1*, *p.* 15., 1889.

[‡] *Journ. of Morphology*, Vol. i., p. 227. 1887.

[§] In *Ctenolabrus*, vide *Mem. Mus. Comp. Zool. Harvard College*, Op. cit., p. 11.

[‖] *Trans. Roy. Soc. Edin.* Vol. xxxv. Part iii., p. 668. 1890.

[¶] *Mittheil. aus der Zool. Stat. zu Neapel. Bd. viii.*, p. 4. 1838.

" the exterior. The difference between the unripe and the ripe egg is due " to a change in the condition of the yolk, which becomes more liquid and " less granular."* The same naturalist, in a more recent memoir dealing with the ovarian eggs of Teleosteans, speaking of the large opaque ovarian eggs of the gurnard, says—" Eggs which are larger than this begin to " grow transparent again. . . . As the egg approaches the ripe condi- " tion both the oil-globules and the vitelline begin to fuse together, . . . " the vitelline globules in fusing form a continuous liquid, in which the still " unfused globules remain suspended." In describing the ovarian eggs of the turbot he points to the fact that there are scarcely any intermediate stages between the opaque eggs and the mature transparent eggs, " but in " the nearly ripe condition the protoplasmic strands separating the yolk- " globules are not visible towards the centre of the egg. It is evident, " therefore, that the fusion of the yolk-spherules takes place almost " simultaneously. . . . that the yolk swells considerably during the " final stage of maturation."† Further, M'Intosh and Masterman, in their recent work on the life-histories of marine fishes, describe the change as a " clearing up of the yolk mass before ripening," that " towards maturity " the granules of the yolk disappear and the ovarian egg becomes quite " translucent."‡

About seven years ago, when making an investigation on the fecundity of marine fishes, and consequently examining a number of ovaries, I was much impressed with the striking change that takes place at maturation in pelagic eggs; and I then described the " more or less sudden increase in bulk that occurs in the ovum shortly prior to its extrusion," and stated that it seemed " to be due to sudden accession of fluid from the ovarian " follicles, which increases the bulk of the ovum and renders the opaque " contents clear by dilution." I also stated that it was at this stage of "hyaline enlargement" that pelagic ova first acquired the property of buoyancy; that a similar but less marked change occurred in certain demersal ova, and that " the process is probably essentially similar both in " pelagic and such demersal ova." I was, however, in error, I believe, in supposing that the change does not occur in all demersal eggs; further research will probably show that it is common to all. In the same paper I stated that the degree of the increase of bulk varied in different species, and showed that the translucent ripe eggs of the plaice were about four times larger, and about four times heavier, than the large opaque eggs just before the change took place.§

In describing the changes which occur at maturation I shall first of all deal with the prominent physical features and properties.

The most striking change is the transformation in the appearance of the ovum from an opaque sphere, chalky white by reflected light, to a clear globe of crystalline transparency, looking like a droplet of dew.

Another change, perhaps less obvious to the eye, is even more significant, namely the great increase in volume which occurs. From the fact that the eggs are spherical (although not always perfect spheres) a slight increase in the diameter may not attract much attention, although it may mean a considerable increase in the volume. The formula for the contents of a sphere is $v = \frac{11}{6} \times d^3$; and applying this to the eggs at the opaque stage and at the mature translucent stage it will be found that there is a very great difference in the volume in the two cases. For example, the large opaque egg of the plaice with a diameter of 1·21mm. has a volume of 0·9276 cubic millimetres, while the mature translucent egg with a diameter of 1·88mm. has a volume of 3·479 cubic millimetres, nearly a four-fold increase. Another series of eggs of this species gave a mean diameter of 1·1mm. for the opaque, with a volume of 0·6969 cubic millimetres; and of 1·93mm. for the translucent, with a volume of 3·764 cubic millimetres. It has to be noted that the eggs, although spherical, are not usually perfect spheres, and this is especially true of the opaque eggs. The eggs of different females of the same species, and even of the same female, also differ a little in dimensions. It is therefore necessary to measure a considerable number to obtain a mean diameter. But making all allowance for this variability and source of error, the difference in the volume of the egg in the two stages is very great.

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* The Natural History of the Marketable Marine Fishes of the British Islands, pp. 71, 97. 1896.

† *Quart. Journ. Micr. Sci. Vol. xl. Part i., pp.* 102, 110.

‡ The Life-Histories of the British Marine Food-Fishes, pp. 18, 72. 1897.

§ The Comparative Fecundity of Sea Fishes, *Ninth Annual Report Fishery Board for Scotland, for the year 1890. Part iii*, p. 243. 1891.

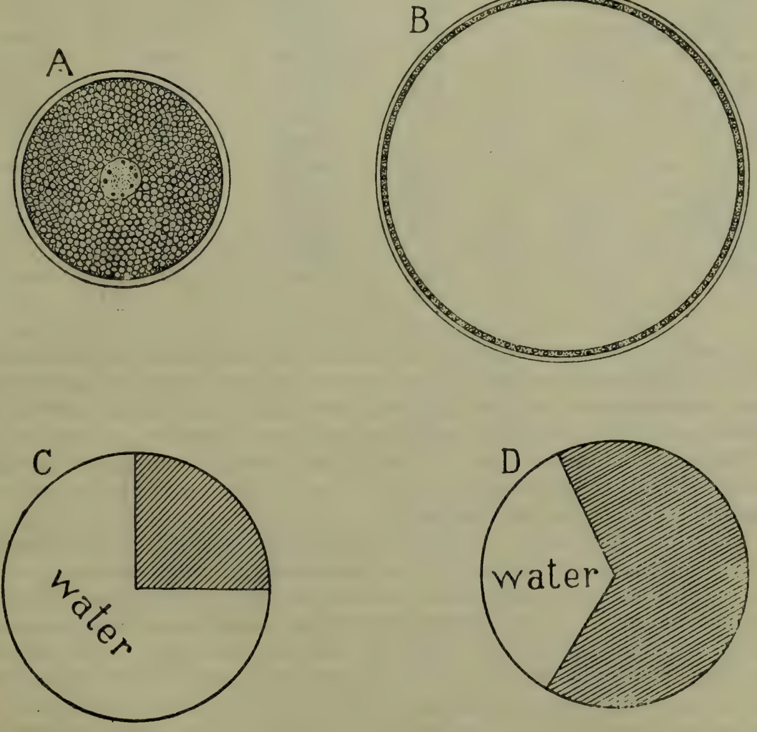

Fig. I. A. Opaque egg of plaice × 20 ; diameter, 1·21mm.; volume, 0·9276cmm.; sp. gr., 1·070. B. Ripe egg of plaice × 20; diameter, 1·88mm.; volume, 3·479cmm.; sp. gr., 1·025. C. and D. Diagrams showing the volume of watery fluid that enters the pelagic and demersal egg (herring) at maturation ; the shaded part represents the yolk of the opaque stage.

In the following Table I give the respective volumes of the large opaque and the mature translucent pelagic eggs of a number of Teleosteans, the calculations being partly founded on the mean of measurements of the diameter made by Williamson* as well as on my own observations.

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* On the variation in size of certain Pelagic Ova. *Thirteenth Annual Report Fishery Board for Scotland, Part iii.*, p. 271. 1895.

Species.	Opaque.		Mature.	
	Diameter in mm.	Volume in c. mm.	Diameter in mm.	Volume in c. mm.
Grey Gurnard, . .	0·9	0·3817	1·45	1·5962
Red Gurnard, . . .	1·0	0·5236	1·55	1·9498
Lesser Weever, . .	0·8	0·268	1·32	1·2042
Mackerel, . . .	0·85	0·3215	1·25	1·0226
Dragonet, . . .	0·7	0·1795	1·0	0·5236
Cod, ...	0·9	0·3817	1·38	1·3706
Haddock, . . .	1·0	0·5236	1·45	1·5962
Bib, ...	0·6	0·1130	0·92	0·4072
Whiting, . . .	0·8	0·268	1·2	0·9047
Saithe, ...	0·8	0·268	1·16	0·8172
Ling, ...	0·	0·1795	1·08	0·6595
Tusk, . , . .	0·9	0·3817	1·3	1·1503
Halibut,* . . .	2·5	8·1812	3·8	28·732
Long Rough Dab, , .	0·8	0·268	1·1	0·6969
Turbot, ...	0·7	0·1795	1·02	0·5556
Brill, ...	0·8	0·268	1·3	1·1503
Sail-fluke, . . .	0·75	0·220	1·13	0·7555
Plaice, ...	1·1	0·6969	1·93	3·764
	1·21	0·9276	1·88	3·479
Lemon Dab, . . .	0·8	0·268	1·3	1·1503
Witch ,, . . .	0·75	0·2209	1·15	0·7963
Common ,, . . .	0·56	0·0919	0·85	0·3215
Flounder, . . .	0·65	0·1437	0·92	0·4072
Sole, ...	0·9	0·3817	1·4	1·4367
Solenette, . . .	0·8	0·268	1·2	0·9047

It will be observed that the ratio of increase does not always correspond in different species, a circumstance no doubt due in part to the true mean diameter not having been ascertained; partly also to an actual difference in the amount of expansion in different species.

The fact, however, that a threefold or fourfold increase in volume occurs in pelagic eggs at the end of ovarian growth is, I think it will be admitted, of considerable interest.

The third important physical change that occurs is in the specific gravity of the ovum, which is much diminished. All opaque eggs sink in sea water, and all mature translucent eggs float in sea water of ordinary density. It is this property of the mature ovum that renders it *pelagic*; before the change occurs it is a demersal egg. This may be readily shown by cutting out a small portion from an ovary containing both ripe and opaque eggs, and shaking it gently in a beaker of sea water, when the ripe eggs float to the top and the few opaque eggs which have become separated fall at once to the bottom. The specific gravity of ripe pelagic eggs of different species varies considerably, but it may be said to range between about 1023 and 1027. There is also a considerable variability in the specific gravity of the eggs of the same species and of the same female. I found a batch of fertilised eggs of the plaice in the multicelled stage to possess a specific gravity ranging from 1024·8 to 1026.

I was desirous of determining the density of the large opaque eggs and of the mature eggs for each species, and during last spawning season I made a large number of observations by using sea water mixed with a saturated solution of common salt or with distilled water, and a delicate Challenger hydrometer was used for this purpose. I found, however, that these observations were vitiated, inasmuch as the penetration of the salt solution into the eggs was too rapid to allow an accurate determination to be made, and the method had to be abandoned. Dr. Milroy, however, has determined the specific gravity in a number of cases (see p. 135) quite sufficient to bring this change in the physical properties of the eggs into line with the others. Thus the opaque eggs of the plaice, with a mean diameter of 1·13mm., had a specific gravity of 1·070, while the mean specific gravity of the mature translucent eggs is about 1·025.

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* The measurements in this case are founded on those given by Brook, Holt, and M'Intosh. It has been overlooked that Brook first described the ripe eggs of the halibut in 1886. See *Fourth Annual Report, Fishery Board for Scotland*, p. 224. 1886.

Another physical change, not so obvious, but still easily demonstrated, takes place when the enlargement of the ovum occurs at maturation; and it is a change of considerable interest as showing the nature and comparative rapidity of the expansion. The egg-capsule or zona radiata becomes attenuated and the surface markings separated by the stretching of the membrane. The change is precisely of the nature one would expect to be presented by the patterns on the surface of an elastic spherical shell which had undergone mechanical distension; but the degree of attenuation does not correspond to what calculation shows ought to occur in a perfectly homogeneous elastic membrane stretched to the same extent. For example, the thickness of the capsule of the large opaque eggs of the plaice is about 0·054mm., and that of the capsule of the mature translucent egg about 0·025mm., while calculation shows that the latter ought to be 0·0163mm., if it were uniformly extensile. The explanation of this circumstance is to be sought in the structure of the capsule, previously referred to (p. 105); the creases or plications are opened out by the forcible expansion of the ovum. The basket-work pattern is therefore much more coarse and obvious in the capsule of the distended mature ovum than in that of the opaque ovum, and, moreover, the dots of the superficial layer are drawn apart. In the eggs of the torsk (*Brosmius brosme*) the surface of the capsule is characterised by the presence of relatively large distinct points or pits; in the opaque egg seven or eight of these were found to lie between two lines 0·05mm. apart, while there were only two or three, and never more than four, in the same distance in the fully mature egg (Fig. 25^B, Pl. I.). The appearance of the basket-work pattern in the opaque and mature eggs of the sole, under the same power, is shown in Fig. 25^A, Pl. I.

The thickness of the egg-membrane in a few species is appended.

Species.	Opaque, in mm.	Mature, in mm.
Grey Gurnard, ...	0·042	0·026
Red Gurnard, ...	0·044	0·020
Cod, ...	0·04	0·022
Haddock, ...	0·043	0·024
Bib, ...	0·016	0·01
Ling, ...	0·027	0·016
Four-bearded Rockling, ...	0·02	0·009
Brill, ...	0·026	0·017
Witch, ...	0·026	0·016
Plaice, ...	0·054	0·025
Lemon Dab, ...	0·036	0·02
Sole, ...	0·03	0·019
Solenette, ...	0·018	0·01

The zona radiata of the mature pelagic egg is thus seen to be very delicate. It is, however, by itself heavier than sea-water, and sinks in it; this may be shown by crushing a number of ripe eggs and washing away the yolk, and then throwing the capsules into the water.

That the hyaline enlargement at maturation is different from the ordinary process of growth is obvious, and it takes place with comparative rapidity. The growth of the egg during the formation of yolk takes many months, in which time the egg of the plaice, for instance, increases slowly and gradually in diameter from about 0·2mm. to about 1·1mm.; but in the final stage there is a rapid increase from the latter to 1·8mm. The number of transition stages to be found in a ripe ovary is extremely small. Almost all the eggs consist either of the large opaque kinds or of the mature translucent kinds, three or four times their size. This can be readily shown by examining the ripe ovary, either in the fresh condition or after boiling or preservation in hardening agents. If a piece of a quite ripe ovary be dropped into, say, picric acid solution, the distinction between the two sizes, the rarity of intermediate stages, is evident. This fact was strongly impressed on my mind in making the investigation on the fecundity of fishes, when over 400,000 eggs were separately enumerated. If the process was slow and comparable to growth, one should see a great number of eggs at intermediate stages both as regards size and appearance. Whether the change takes hours or days is uncertain.

Transition stages can, however, be found by careful examination of a large number of eggs. Most of them present essentially the same features as the opaque eggs; but they are somewhat larger, the yolk-spherules are larger, and the whole ovum more translucent, resembling the appearance of the mature demersal egg, such as that of the herring. If oil globules exist, they now begin to appear on the surface of the vitellus. These eggs resemble opaque eggs which have been soaked in a weak solution of common salt, and they indicate incipient dissolution of the fabric of the egg. My sections of pelagic eggs do not include any that can be with certainty assigned to this stage. In sections of the ripe ovary of a bib, there is an egg measuring about 0·53mm., in which the germinal vesicle is somewhat excentric, with the nucleoli very minute, and the yolk partly in the condition of large irregular spherules, but mostly homogeneous and somewhat colloid-looking. This homogeneous yolk resembles what is seen in the mature eggs in the same section, except that it is more deeply stained and solid-looking. Other eggs show somewhat similar changes; in some cases the germinal vesicle is flask-shaped or pyriform and large; in other cases normal yolk-spheres are present. But this ovary was not preserved until a considerable time after the death of the fish, and it is not improbable that the appearances mentioned are due to *post-mortem* change. Other transitional stages will be referred to later.

From many considerations it is clear that the cause of the change in the pelagic ovum at maturation is the entrance of watery fluid. This is shown by the transparency, the rapid increase in volume, the solution of the yolk-spherules, the diminished specific gravity. The contrast between the opaque and translucent eggs after boiling, or after immersion in fresh water or hardening agents, shows the same thing. The opaque eggs after boiling or immersion in water become intensely chalky white and harder; the ripe eggs remain soft, and become only slightly milky or opalescent. In picric acid solution the opaque eggs become brown, while the ripe eggs remain straw-coloured; in osmic acid solution the opaque eggs become black, and the translucent eggs brownish grey. Between the fingers or in manipulation on the slide, the difference in consistency is obvious.

These considerations led me in 1891 to state that the change was due to the accession of watery fluid, and the accurate determination of the proportion of water present in the two stages, which Dr. Milroy kindly made at my request, shows that such is the case. In the mature eggs of the plaice, dried to a constant weight at 60°C., 80°C., 100°C., and finally at 105°C., the percentage of water was found to be the very high one of 91·86, while in the opaque eggs treated in the same way the quantity was only 65·5 per cent. Later determinations in other cases will be given by him in his report. (See p. 137.)

It has been already said that this change in the egg at the conclusion of ovarian growth is not confined to the pelagic forms, but that it also takes place in demersal eggs. I believe this fact to be of great importance and significance. In the pelagic ovum one perceives at once, as a result of the absorption of watery fluid, the diminution in the specific gravity, by which the egg is enabled to float and to become a member of the pelagic fauna. Had the change been peculiar to pelagic eggs, one might have been justified in supposing that the function of the absorbed fluid was simply hydrostatic, and that the concomitants of the process—the solution of the yolk-spherules, and the vanishing of the germinal vesicle —were not related to it. But when the same thing is found to occur at the final stage of maturation of demersal eggs, in which diminution of specific gravity is of no utility, quite a new light is thrown upon the nature and significance of the process. For the fundamental and essential feature of the maturation of the demersal egg is the disappearance of the germinal vesicle and the transference of the chromatic substance to the periblast—a phenomenon which also accompanies the absorption of fluid in the pelagic egg. The conclusion is therefore warranted that the fluid which enters the ovum is associated with the dissolution of the germinal vesicle. And if this is so, then it is extremely improbable that it should be confined to the teleostean egg. It will, I think, be found to occur normally in the maturation of the eggs in other groups—such, for example, as the Mammalia; in other words, that the transformation of the germinal vesicle, the causation of which has been hitherto obscure and mysterious, is caused by the physico-chemical action of fluid which enters the egg at the close of ovarian growth.

My investigation of the maturation of the demersal eggs of Teleosteans is not yet completed; but I have found the absorption of fluid, with the concomitant disappearance of the germinal vesicle, the enlargement of the egg, and the partial "clearing up" of the yolk, to occur in all those which I have recently been able to examine in the ripe condition and in the previous opaque stage—viz., the herring, the armed bullhead (*Cottus scorpius*), the lumpsucker (*Cyclopterus lumpus*), and the angler (*Lophius piscatorius*); and from the assumption of translucency in other forms there can be no doubt it occurs in all. I have found the same translucent change in the eggs of *Cottus bubalis*, *Liparis montagui*, *Anarrhichas lupus*, *Gasterosteus spinachia*, *Syngnathus acus*, and *Ammodytes tobianus*; and M'Intosh and Prince,* Holt,† Cunningham,‡ and several other writers refer to the translucent appearance assumed by the ripe demersal eggs of many species.

While the nature of the change is the same both in the pelagic and demersal ovum, the relative quantity of fluid absorbed is much less in the latter than in the former. In the majority of cases, at least, the yolk-spherules are not all dissolved, although many of them flow together, and the vitellus appears more translucent and watery and increases in size.

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* Op. cit., p. 668.

† *Sci. Trans. Roy. Dublin Soc., Series ii. Vols. iv., v.*

‡ Nat. Hist. Marine Fishes, p. 71, &c.

In the angler, while the nearly mature eggs present the usual appearance of dense opacity to transmitted light and chalky whiteness to reflected light, the almost mature egg looks like a melting snowball or a moistened lump of sugar, and the yolk spherules are seen to be clearer and larger (Fig. 5, Pl. II.). The egg is also now much softer and more readily ruptured. In the herring the translucent change is even more marked, and some of the yolk-spherules, in the fresh egg, measure fully 0·09mm. On rupturing the capsule some of them coalesce and flow out as large watery-looking globules. The increase in volume is much less than in the pelagic eggs. A series of measurements of 46 large opaque eggs of the herring gave a mean diameter of 1·18mm., as compared with a mean diameter of 1·33mm. for 62 of the ripe semi-translucent eggs. The respective volumes were, therefore, about 0·86 cubic millimetres and 1·23 cubic millimetres. The different condition in the two cases is also well brought out in mounted sections, as is shown in Figs. 16, 17, Pl. I.; but it is to be noted that in the ripe egg of the herring, as well as of the angler, the process of preparation causes the yolk spheres to coalesce still further, so that they appear much larger than in the fresh eggs, and they also for the most part lose their spherical shape. The commencement of the aggregation of protoplasm to form the large blastodisc is well represented in Fig 17. It would appear from a consideration of the eggs of the herring and angler that the entrance of fluid into the demersal ovum at the close of ovarian life takes place more slowly than in the case of pelagic eggs. I have examined herring roes in which the whole mass of eggs distinctly showed incipient translucency while the germinal vesicle was still present.

It thus appears that in the case of the pelagic egg, Natural Selection has, so to speak, seized upon and greatly exaggerated a phenomenon common to the teleostean egg for another and quite different purpose—namely, to enable the egg to float.

Certain questions arise in connection with the entrance of watery fluid into the egg:—(1) What is the composition of the fluid? (2) what is its origin? (3) how is the absorption effected? (4) what determines the change at the close of ovarian growth?

It is reasonable to assume that the fluid which enters the egg is secreted by the cells of the follicle, because the egg is everywhere closely invested by these cells, and if it is not secreted by them it must pass through them from the tissues around; but the free fluid in the stroma is blood plasma, which has itself a much higher specific gravity than the mature egg, and it therefore cannot be the agent. There is no other structure in the ovary, except the follicle, to which the origin of the watery fluid can be assigned. The follicle of the growing pelagic ovum consists of a continuous single layer of minute flattened cells closely applied to the surface of the egg-capsule, and with a small amount of connective tissue around it containing a meshwork of capillary blood-vessels (Fig. 14, Pl. I.). It forms a thin membranous tunic of moderate toughness, and may sometimes remain unruptured when the zona is ruptured by pressure, and the yolk then passes between it and the latter. In demersal eggs it is much thicker and more resistant, the granulosa layer being frequently double. The connective tissue stroma of the ovary is very loose; it also is more abundant and dense in ovaries producing demersal eggs.* The follicular cells of the plaice, for example, are irregularly rounded or lozenge-shaped, flattened, with a scaly margin and a large prominent nucleus, and they measure about 0·009mm. in diameter. The surface of a large immature ovum of this species is equal to about 4 square millimetres, and the follicular cells covering it will therefore number close upon 50,000, and from the large size of the nucleus and the scanty cytoplasm, it is obvious that the follicular layer must form a potent secreting organ. The cells resemble the epithelioid cells from a serous membrane.

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* I may say here that one may infer with considerable certainty, from a comparatively early stage in ovarian development, whether the mature eggs are likely to be demersal or pelagic, from the conditions stated, the double-layered or single-layered zona, and the character of the yolk spherules.

The assumption is also reasonable that the fluid which enters the ovum at maturation is essentially the same as the free watery fluid found in the cavity of the ovary bathing the ripe eggs after the latter escape from the follicles; and which, therefore, probably represents a surplus secretion by the follicular epithelium after the escape of the ovum, and its abundance will ensure that each egg obtains sufficient to saturate it. As to the mode by which the fluid enters the ovum, it seems to me not improbable that the process, at least in the later stage, is essentially osmotic, the watery solution of crystalloid (chloride of sodium) entering through the egg-membrane, and an osmotic equivalent of albuminous matter passing out. The question remains as to whether this watery secretion of the follicular cells is only formed towards the close of ovarian growth, or is the normal secretion. If it is the same as the normal secretion of the follicular cells, and represents the form in which these cells prepare the pabulum from the blood plasma in the stroma for the ordinary growth of the egg—if this function of the follicle undergoes no modification in the later stages—then it is evident that some part of the ovum itself must undergo a change by which the ordinary assimilative metabolism is brought to a close. According to this view the follicular epithelium continues to perform its normal function of preparing a watery saline solution of albumins which cannot be assimilated owing to the decay of some part of the ovum that governs assimilation.

It may be worth while considering this theory a little. The great mass of the opaque ovum consists of yolk spherules and granules imbedded, or immersed, in a fluid matrix or menstruum, which forms a multitude of channels between the cortex and the germinal vesicle; and we know that the formation of the yolk granules goes on throughout the whole of the cytoplasm. In most cases the larger, and therefore older, spherules are to be found some distance below the cortex; in some cases they are placed nearest the cortex, those in the neighbourhood of the germinal vesicle being small (Fig. 11, Pl. II.), and therefore probably newly formed. There must be within the vitellus a continuous circulation of the secretion derived from the follicle, and after the constituents which go to form the more solid yolk-spherules are withdrawn, the excess of water must be returned by the follicular epithelium to the stroma. From what is known regarding the function of the nucleus in the synthetic metabolism of the cell, it is, I think, certain that it is in the germinal vesicle that we must seek the controlling agency of the general metabolism of the ovum, although the formation of the cortical protoplasm may take place *in situ*, and become transferred inwards. And, moreover, in the teleostean ovum it is, I believe, the nucleoli that must be regarded as the most obvious active agents. We have seen that they are numerous and large, and are closely applied to the membrane of the germinal vesicle during the period of yolk formation, while towards the close of ovarian growth many, or it may be all (Fig. 5, Pl. III.), of them pass inwards towards the centre of the vesicle, and break down. This change in the nucleoli precedes the complete hyaline enlargement at maturation, and it is not improbable that, when the ovum has attained the specific size and condition, the nucleoli lose their metabolic function, so that the secretion derived from the follicular cells is no longer assimilated, and is retained.

THE HISTOLOGICAL CHANGES AT MATURATION.

The minute changes occurring in the ovum at maturation, associated with the dissolution of the germinal vesicle, are more difficult to detect, and I have been scarcely more fortunate than other observers in tracing them in the teleostean egg, except, perhaps, in that of the angler, to be presently described. The chromosomes which go to form the polar bodies and the egg nucleus are, of course, very small compared with the germinal vesicle or the nucleoli, and the formation of these structures appears to take place only after fertilisation.* The hyaline enlargement, as has been previously described, appears to take place more rapidly in pelagic than in demersal eggs, and none of my sections show with certainty the alterations in the germinal vesicle. But I have found some transitional stages in the fresh ovaries. In that of the red gurnard I found a translucent egg measuring 1·41mm., the fully distended ovum measuring 1·55mm., and the opaque about 1mm. By careful illumination the faint outlines of a few enlarged spheres could be made out in the interior of the translucent vitellus. In the ovaries of a flounder which was practically spent, the cavities being collapsed and the contents consisting mostly of a number of translucent eggs and abundant fluid, I found some of the eggs presenting transitional appearances. Many of the eggs showed distinct *post-mortem* changes—that is to say, they exhibited a faint opacity, and on microscopic examination the periblast was found to have shrunk from the zona, to be greyish or brownish, granular and friable. Among these eggs others were found in the earlier stages of expansion. They measured from about 0·72mm. to 0·78mm., the fully mature ovum measuring in this species about 0·92mm., and the position of the germinal vesicle was defined as a clear spot measuring about 0·22mm. In an isolated germinal vesicle of this size no nucleoli were detected, and it was seen to be very finely granular (Zeiss E. oc. 2). The yolk spheres had increased in size, some of them measuring 0·19mm., and some of them presented the peculiar appearances shown in Fig. 19, Pl. I.; in some, part of the margin was fretted and ragged, in others the whole edge was in this condition, and they had, as a rule, fine granules dispersed throughout them, but some were clear vacuoles. A number of the larger opaque eggs were soaked all night in a 1 per cent. solution of common salt, and in the morning some were found to be enlarged, and showing a clear perivitelline space. On slight pressure under the cover-glass, the yolk-spheres ran together, forming curious figures; they were obviously droplets of liquid. The germinal vesicle was small, and measured in one case 0·16mm.

In other eggs in this ovary a lenticular blastodisc was formed which sometimes showed irregular pseudo-cleavage and disintegration, sometimes it appeared healthy; other eggs showed the periblast in continuous contact with the zona. But many full-sized translucent eggs exhibited other features associated with the presence of vacuoles in their interior, some of which are represented in Figs. 20–24, Pl. I. The one most closely resembling those above described measured 0·86mm., and in it the vacuoles—obviously derived from the fusion of yolk-spherules—were very large, one measuring 0·27mm., and of unequal size; their interior sometimes, but not usually, contained a few scattered granules. The egg was not transparent, but it was translucent, and no clearer spot indicated the presence of a germinal vesicle. On focussing down, a large, faint, but definite circle was observed (Fig. 20). Other eggs, transparent and full-sized, presented the appearance shown in Figs. 21–24. In Fig. 21 the vesicle *b* was faintly and finely dotted, and contained one small refringent body. In Fig. 22 more small vesicles were present at the periphery, some of the largest measuring 0·11mm.; 23 and 24 show other appearances. The latter was treated with dilute acetic acid, a few drops of 5 per cent. solution being added to the ovarian fluid in which the eggs were lying, and the spot *a* became dark, while the rest remained unaltered. Many other eggs exhibited similar characters.

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* Agassiz and Whitman, *Mem. Mus. Comp. Zool. Harvard Coll.*, Vol. xiv., Part ii. 1, p. 12. 1889. Some observers have described the elimination of polar bodies from unfertilised teleostean eggs, as Hoffmann, Cunningham, Kingsley and Cohn; the latter admit the possibility of the eggs having been fertilised.

The interpretation of all the appearances is not clear. There is little doubt the vesicles aggregated at the periphery of the large vesicle represent yolk-spherules which have fused, but the other features are not easy to explain. They are not the ordinary changes which occur after the death of normal mature eggs, as I showed by experiment in those of the flounder for this purpose, as well as in those of the plaice, to ascertain the *post-mortem* changes associated with loss of buoyancy.

In the egg of the angler I have been able to examine the germinal vesicle in the process of dissolution. The condition of the germinal vesicle in some of the larger eggs containing normal yolk-spherules has been already explained. In the ovary of a fish containing ripe eggs I found some as represented in Fig. 13, Pl. II. The germinal vesicle of the central egg in this figure is shown in Fig. 4, Pl. III., as it appears under Zeiss oil-immersion lens 2mm., and compensating ocular 4, with the tube drawn out. In these eggs it will be seen that the yolk-spherules have fused to a considerable extent, owing to the entrance of the follicular fluid; and in the egg under consideration the germinal vesicle has moved to the side of the egg-capsule (*a*), and is obviously disintegrating. It is irregular in shape, the bounding membrane has disappeared, except, perhaps, at the part furthest from the egg-capsule, where the margin is in parts regular in outline, and a faint double contour can here and there be made out. At the outer part the substance of the germinal vesicle is continuous with the very scanty cortical protoplasm, and is apparently fusing with it. The ground substance of the vesicle has a granular appearance, but careful examination in a good light shows that it is composed of a fine irregular meshwork of granular threads, which are made more obvious with compensating ocular 12 (= 1440 diameters), and are specially noticeable at the frayed margin and at the thin part near the zona radiata. The threads have not, however, the regularity of moniliform pattern shown in Fig. 5, Pl. III.; they appear somewhat shrunken. The most notable feature is the presence of very numerous spherical granules, vesicles, or corpuscles slightly stained, some more than others, contained among the meshes of the network. These may be seen here and there throughout the whole substance of the vesicle, but they are mostly aggregated in the neighbourhood of the nucleoli which are near the zona radiata, and between them and the latter. They vary in size, the largest measuring 0·0035mm.; many are not a third of that size, and they are not disposed in linear fashion, as in Fig. 5, but apparently placed without any orderly arrangement.

The nucleoli are six in number in the section, and they are very conspicuous. The two larger measure 0·0168mm., and the smallest

0·008mm. They are globular, and appear to consist of a thin shell full of numerous spherical granules or vesicles, or both. The larger spheres, from their pale unstained appearance and their size, seem to be vesicular; the largest of these measures almost, but not quite, 0·007mm.; the smaller correspond closely in size and appearance to the free spherical granules or vesicles in the meshwork. One of the nucleoli contains no granules or vesicles, and seems to consist merely of the shell, which is somewhat crumpled. The conclusion seems warranted that the free granules are derived from the breaking down of the nucleoli. Other sections of this germinal vesicle show the same thing, as well as sections of the germinal vesicles in other eggs in the same ovary, less excentrically placed, the nucleoli in these being all aggregated at one side.

In one or two cases only was I able to detect the chromosomes in these eggs. Fig. 7, Plate III., represents the edge of a germinal vesicle, showing four nucleoli in process of disintegration, and between two of them the chromosomes were distinctly visible.

The conclusions to which I have arrived with regard to the changes at maturation in the eggs of teleostean fishes may be summarised as follows:—

(1) In both pelagic and demersal eggs the final stage at the close of ovarian growth is characterised by the entrance into the ovum of a certain quantity of watery fluid of low specific gravity. This fluid is secreted by the granular cells of the follicle, and is probably essentially similar in composition to the free fluid found in ripe ovaries producing pelagic eggs.

(2) This fluid causes the more or less complete fusion or solution of the yolk-spherules, and hence the translucency or transparency of the vitellus; and it is associated with the dissolution of the germinal vesicle and the rearrangement of the chromatic substance concerned in fertilisation and heredity; also with the escape of the egg from the follicle.

(3) In pelagic eggs which float isolated in the sea, the quantity of fluid that enters the ovum is very large, distending it to three or four times its former volume, and completely dissolving the yolk-spherules; and that such eggs float by virtue of the large quantity of fluid of low specific gravity absorbed.

(4) That in one form at least (*Lophius piscatorius*), and probably in others, this change is preceded or accompanied by a change in the constituents of the germinal vesicle, the nucleoli travelling towards the centre of the latter, and breaking up into minute stained granules, which may possibly take part in the formation of chromosomes. The hydrolytic change may be due to decadence of the histogenetic function of the nucleoli, the components of which then break up as described.

To these I may add

(5) That inasmuch as the entrance of fluid in demersal eggs has no hydrostatic function, and is of no utility in connection with the external relationship of the ovum, the same change is probably of normal occurrence in the maturation of the ovum in other groups of vertebrates, and in some groups of invertebrates.†

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† Fol, in his early observations on the transformation of the germinal vesicle of *Asterias glacialis*, states that the change does not occur until the egg has reached the sea water. It is not improbable that in some forms there may be direct absorption of sea water instead of follicular secretion.

THE RELATION OF THE CHANGE IN THE PELAGIC OVUM TO CERTAIN PHENOMENA IN THE LIFE-HISTORY OF THE SPECIES.

In the floating egg itself it may be noted that the aggregation of germinal matter or blastodisc, and the embryo, are placed inferiorly owing to the lower specific gravity of the diluted yolk. Reference has also been made to the sinking of the embryo or larvæ as the yolk is absorbed, from the increasing specific gravity of the tissues into which it is transformed, and to the correlation of the inferior nutritive power of the diluted yolk and the characters of the larvæ. In cases where the yolk consists of solid plates, as among Elasmobranchs, or semi-solid spherules, as among most demersal eggs, the apparatus or arrangement by which it is rendered available for assimilation is necessarily more complicated than in pelagic eggs, where the heart of the embryo opens directly into the fluid yolk, and where the absorption is a comparatively simple process. Comparison of the larvæ which issue from demersal and pelagic eggs shows the difference in the nutritive power of the yolk in the two cases. Thus, the egg of *Cottus scorpius* is of about the same size as the egg of the plaice—the yolk alone, indeed, is somewhat smaller. The former hatches in between three and four weeks. The larva is about 7·5mm. in length, and has the mouth open, and is in other respects well developed. The egg of the plaice at the same mean temperature hatches in about sixteen days; the larva is about 4·1mm. long, delicate and slender, destitute of a mouth, and is otherwise ill developed.

Thus a group of facts associated with the embryonic and larval stages is explicable by a knowledge that the yolk is diluted in pelagic eggs.

Another group relates to the adult condition. The rapid expansion of the ovum to three or four times its previous size makes it physically impossible for a female producing pelagic eggs to carry all her eggs in the mature distended state, because the volume of the ripe eggs may approximate to or exceed the volume of the body of the fish. Fishes whose eggs are pelagic are far more fecund than those whose eggs are demersal.* I have computed the mean number produced annually by each female of twelve species with demersal eggs to be 24,700, while the mean number produced by each female of thirty species with pelagic eggs is 2,388,000. This excessive fecundity, while dependent for the most part on the vicissitudes to which a wandering egg is exposed, is also, no doubt, related to the imperfect character of the embryo when born. Some species could possibly carry all their eggs if the mature condition was the opaque stage before hyaline expansion occurs, and they were then extruded. The mean gross volume of the eggs produced each season by a female in a number of species is nearly as follows—the calculation being based upon the average volume of the individual egg and the number of eggs produced:—Plaice, 1129 cubic centimetres; cod, 6233 c.c.; haddock, 718 c.c.; turbot, 4723 c.c.; halibut, 86,196 c.c. A female cod, 32½ inches in length, and weighing 14lb. 1oz., had a volume of 6250 c.c. The ovaries, which contained fully matured eggs, and were probably partly spent, weighed 3lb. 3oz., and possessed a volume of 1682 c.c., so that the volume of the body of the fish, minus the ovaries, was 4568 c.c. It was calculated that the number of eggs present was over 4,550,000, which, in the mature distended state, would occupy a volume of about 6261 c.c., or considerably greater than the bulk of the fish. In the flounder, again, which is probably the most fecund of sea fishes, the contrast is still more striking. A very large female examined in

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* *Vide* Comparative Fecundity of Sea Fishes. *Ninth Annual Report, Fishery Board for Scotland, Part iii., p.* 243.

February, when the eggs were not fully mature, weighed 1lb. 15½oz., and was 16½ inches long. The gross volume of the fish was 951 c.c.; the ovaries, which weighed 6½oz., had a volume of 170 c.c., so that the volume of the body was 781 c.c. The number of eggs in the ovaries was computed to be 2,733,000, the volume of which in the mature state would be about 1114 c.c.

The expansion of the pelagic ovum at maturation is therefore a direct cause of the prolonged spawning period in those species whose eggs are pelagic. In conclusion, it may be said that a comparison of the change in the demersal and pelagic egg does not support the hypothesis that the pelagic ovum is the more primitive type, because the latter exhibits a more specialised development of a feature that is common to both, and whose primitive significance is unconnected with the flotation of the ovum.

EXPLANATION OF PLATE I.

Fig. 1. Section of ovary of haddock (Zeiss A. oc. 4).

Fig. 2. ,, ,, ,, × 200.

Fig. 3. ,, ovum of gurnard × 200.

Fig. 4. ,, ova of plaice × 200.

Fig. 5. ,, ,, ,, (Zeiss A. oc. 4).

Fig. 6. ,, ovum of eel, showing oil vacuoles.

Fig. 7. ,, ,, solenette × 120.

Fig. 7a. Germinal vesicle of young ovum in same section.

Fig. 8. Ovum of flounder, showing the presence of the internal vitelline membrane.

Fig. 9. The same, more magnified.

Fig. 10. The same, showing its presence in the unruptured egg.

Fig. 11. Showing the germinal vesicle escaping by pressure.

Fig. 12. ,, ,, ,, ,, ,, ,,

Fig. 13. ,, ,, ,, ,, between two ova on slide.

Fig. 14. Section of mature hyaline egg of plaice, with a small part of the yolk still undissolved. The egg-capsule is shown too thick and swollen.

Fig. 15. Section of mature hyaline egg of plaice, the yolk-spherules completely dissolved.

Fig. 16. Section of unripe ovum of herring, showing the yolk-spherules, germinal vesicle, three-layered zona.

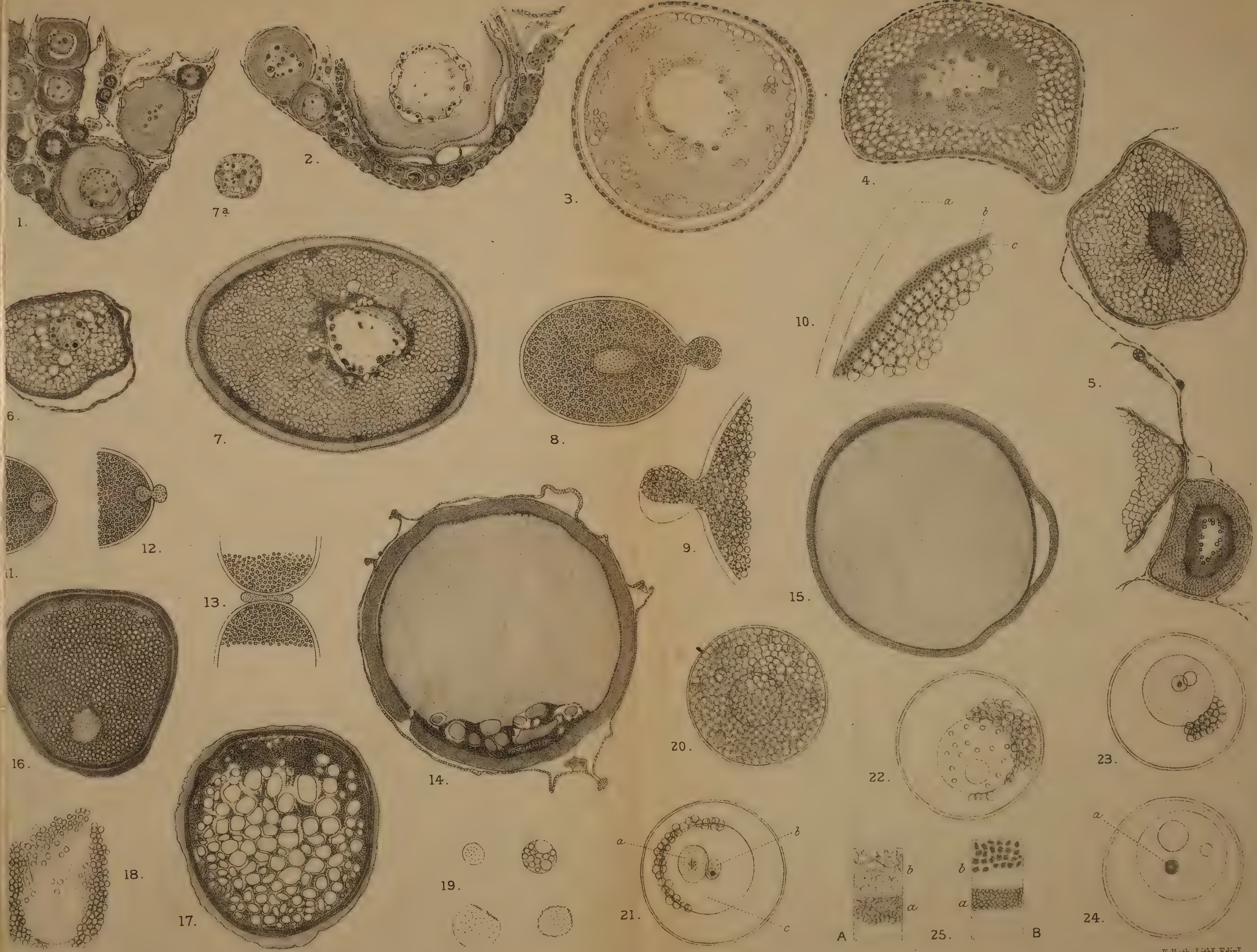
Fig. 17. Ripe egg of herring, showing the partial fusion of the yolk-spherules and the aggregation of the germinal protoplasm; germinal vesicle disappeared.

Fig. 18. Germinal vesicle of lemon sole in the fresh condition, showing fibrillæ passing among the yolk-spherules.

Fig, 19-24. Transition stages from the nearly spent ovary of a flounder, showing various appearances.

Fig. 25. Surface markings on zona radiata of sole (A) and tusk (B); *a*, of opaque eggs; *b*, of translucent mature eggs.

Pl. I.



G.B. Figs 1-5, 7.
J.G. „ 6, 14-17.
W.F. „ 8-13, 18-25.

F. Huth, Lithr Edinr

III.—THE OVARIES AND OVARIAN EGGS OF THE ANGLER OR FROG-FISH (*LOPHIUS PISCATORIUS*), AND OF THE JOHN DORY (*ZEUS FABER*). BY T. WEMYSS FULTON, M.D., F.R.S.E., Scientific Superintendent. (Plates II., III.)

1. THE ANGLER OR FROG-FISH (*Lophius piscatorius*).

The embryonic development of this fish has been described by Agassiz and Whitman,* and by Prince,† but hitherto no detailed account appears to have been given of the ovaries and ovarian eggs. Some years ago I described the ovaries in a female caught in January as forming a wide, flattened, thin-walled tube, about twenty feet in length, the eggs being arranged in a layer in the form of a band occupying half the circumference of the tube, and I stated that they were coiled up in the abdominal cavity and exhibited worm-like or gliding movements.‡ More recently I have been able to make a more complete study of the ovaries and ovarian eggs.

The ovaries are confluent, and, as stated, form a single, long, flattened tube or band, whose dimensions vary with the size of the fish and the season of the year. In the following Table are given the dimensions and particulars of some of the ovaries examined :—

Date.	Length of Fish.	Place of Capture.	Ovaries.				
			Length.	Breadth	Thickness.	Weight.	Condition.
Feb. 18, 1891,	4 feet	E. Coast.	36 feet.	10 in.	..	10½ lbs.	Nearly ripe
Mar. 28, ,,	..	,,	§91 feet.	..	..	over 25 lbs.	..
May 25, ,,	3 feet 8 in.	Firth of Forth.	17 feet 7 in.	..	..	4 lbs. 2 oz.	..
July 7, 1897,	3 feet	24 miles E. of May Isle	17 feet 1 in.	6¾ in.	3mm.	5 lbs. 13 oz.	Not ripe
Feb. 9, 1898,	4 feet	3 miles W. Bell Rock.	8 feet 10 in.	3½ in.	..	..	,,
,, 11, ,,	4 feet 2 in.	7 miles S. S. E. May Isle.	29 feet 1 in.	13½ in.	4mm.	14 lbs. 6 oz.	Almost ripe
,, 12, ,,	,, ,,	5 miles S. S. E. May.	9 feet 8 in.	4¾ in.	..	2 lbs. 5 oz.	Not ripe
,, 17, ,,	..	Off May Isle	29 feet.	7 in.	..	9 lbs. 2 oz.	,,
,, 24, ,,	..	,,	23 feet 2 in.	8 in.	..	6 lbs. 3½ oz.	,,
Mar. 5, ,,	..	,,	3 feet 2 in.	1 in.	..	..	Immature

As the floating gelatinous band in which the eggs are imbedded has been found as late as July, it would appear that the spawning period of *Lophius* extends from February to about the end of June. Large females examined on the 9th and 11th July were spent; a female three feet nine inches long, caught on 20th May, had the eggs scarcely half developed; one, two feet six inches in length, caught on 21st May, was in the same condition; one, two feet three inches long, caught on 22nd November, was less advanced.

In the specimen with almost mature eggs, caught on 11th February, the ovaries measured a little over 29 feet in length, the greatest breadth was 13½ inches and the thickness was only 4 millimetres. It formed a long, flat, semi-translucent gelatinous band, soft and easily ruptured, and suspended by a broad but delicate mesovarium (Plate II., fig. 1, *a*). The ovaries form a continuous tube, the oviduct (*b*), which is thick-walled and narrow—admitting a finger with difficulty—opens into it at its middle, at the junction of the ovigerous and non-ovigerous sides. The ovigerous tissue is limited to one side of the tube, the opposite wall of the ovary, which at this stage is a very thin, delicate, translucent membrane, being closely applied to it. On section, therefore, across the length of the ovary the appearance is as shown in fig. 4, the ripe or nearly ripe eggs being arranged in a single layer, imbedded in the tenacious gelatinous matrix.

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* Memoirs of the Museum of Comparative Zoology at Harvard College, Vol. xiv., No. 1, Part i., p. 16 (1885).

† Ninth Annual Report Fishery Board for Scotland, Part iii., p. 343 (1891).

‡ Ibid. p. 245.

§ Dimensions and weight given by Fishery Officer.

At an earlier stage the non-ovigerous wall is considerably thicker (Plate II., figs. 8, 9). No free fluid is present in the ovaries. When a portion of the ovigerous wall is cut out and placed in sea-water it swells up considerably from the absorption of water, the gelatinous matrix becoming mucoid, glairy, and slippery; if it is left exposed to the air it dries up to form a thin film or layer from which the eggs project. The gelatinous matter does not lose its transparency or become white in water or by boiling, and as the eggs become chalky-white under these conditions the piece of ovary looks a mass of half-boiled sago. The ovigerous layer scraped off from the ovary floated in sea water of 1026 specific gravity (temperature 16·8°C.), and the eggs, unless carefully separated from the mass, also float owing to adherent mucoid matter. It is a little difficult to detach the eggs without rupturing them, owing to their very thin capsules; but when this is done they sink in sea-water, although not so rapidly as thick-shelled demersal eggs like those of the lumpsucker. Dr. Milroy determined the specific gravity of the detached eggs to be 1·034.

On dissecting a piece of the ovigerous wall, which has been hardened by spirit or by boiling, especially before the eggs are quite mature, it will be found that each large egg is contained in a pyriform pouch which projects into the cavity of the ovary, and which, in such specimens, may be easily separated at its pedicle (Plate II., fig. 7). It may also be observed that within this pouch at its base there are several small eggs. Hence the internal surface of the ovigerous layer in such specimens has a papillose appearance.

The structure and formation of the ovigerous pouches are better understood from mounted sections. From Figures 8 and 9, Plate II., it will be seen that at the point where the smooth barren wall of the ovary passes into the ovigerous wall the latter is split into two more or less distinct layers, separated by a thin, loose, mucoid or cellular tissue in which are numerous blood-vessels. The connective tissue fibres in the thin outermost layer are for the most part transverse; those in the thicker inner layer are principally longitudinal. The loose intermediate tissue is full of lacunæ, or lymph spaces, which become more marked as the ovary ripens, and are continuous with the interior of the ovigerous pouches. The pouches are formed by digital ingrowths of the epithelium lining the ovarian cavity and of the subjacent connective tissue stroma, which carries blood capillaries with it. Each of them at an early stage contains a number of eggs, it may be about a dozen, two, three, or four of the most distal being at this time sub-equal in size; but as growth proceeds one of the eggs develops much more rapidly than the others and comes to occupy the whole of the cavity except the stalk. The other eggs remain in a stationary condition without forming yolk. In the mature ovary they are crowded and distorted at the base of the large egg in the pedicle of the pouch, where they persist in the spent ovary; in both cases they are vacuolated chiefly at the periphery, and they probably degenerate.

The cavity of the ovary is lined throughout with prominent columnar epithelium (fig. 8 *a*, Plate II.), which, between the bases of the ovigerous pouches, may be in two or three layers (fig. 3, Plate III.). This epithelium is reflected on to the surface of the pouch, where it becomes cubical or rounded and then flattened, and it is difficult to differentiate it in the earlier stages on the sides and top of the pouch. Later, as the yolked eggs become large, the epithelium on the surface of the pouch again assumes a cubical form.

In the early stages gelatinous matter between the pouches is not apparent. Thus in sections of the ovary of a large female caught on 20th May, in which the largest eggs measured about 0·24mm. and were destitute of yolk, the interspaces were free from it; but in a specimen caught on 9th February, in which the largest eggs were full of yolk and measured about 0·9 mm. (in mounted sections), the gelatinous substance formed a layer ranging about 0·17mm. in thickness over the distal ends of the pouches—in some places it was 0·36mm. thick. The quantity between contiguous pouches was very small except in the neighbourhood of the pedicles. In mounted sections of the ovary containing almost mature eggs (1·45mm. in section) the layer covering the eggs measures about 0·32mm. in thickness, and the whole of the rest of the pouch is covered by a thinner layer. The clear gelatinous matter stains faintly but irregularly with hæmatoxylin. With regard to the origin of the gelatinous substance, Cunningham has made the very natural suggestion that it arises by a modification of the outer surface of the zona radiata,* but this is not the case. It is situated not only outside the follicle but outside the ovigerous pouch; that is to say, it lies in the cavity of the ovary, and it is in reality formed as a secretion by the columnar epithelium. The epithelium lining the barren wall of the ovary takes no part in its formation, but that between the pedicles of the ovigerous pouches, and covering the surface of the latter, actively secrete it. The whole of the cells composing the epithelium which lines the ovigerous side of the ovary proliferate, swell up in an extraordinary manner, and undergo a marked transformation, so that they appear as large clear vesicles, reminding one of the so-called *goblet* cells of mucous membranes (fig. 13, Plate II.). On surface view the cells appear polyhedral (fig. 6, Plate II.), and the change that occurs might be described as a mucoid degeneration.

When the large mature eggs escape from their follicles they pass into the gelatinous secretion, and the mass is extruded no doubt gradually. The process of expulsion through the narrow oviduct would appear to be a matter of difficulty; and the mode in which fertilisation takes place is also a little puzzling. If insemination occurred before extrusion of the eggs, impregnation would probably be facilitated; and Yarrell, quoting from Montagu's MS., states that the males and females differ, a point I neglected to investigate. The males, at all events, are much more numerous than the females, in the proportion of 100 to 26, and it is probable that several males attend the female during oviposition.

Sections of the spent ovary show the large pouches, containing the winding wall of the follicles, from which the mature eggs have escaped, and a considerable quantity of gelatinous substance outside, which has split up into a curious comb-like structure and taken a deep stain in preparations preserved in Perennyi's mixture. The small yolkless eggs at the base are vacuolated and apparently degenerating, and it appears that the connection of the pouches with the germinal epithelium and the wall of the ovary ceases. They appear to become detached, and the epithelium may be traced as a thin single layer, the cells being small and rather cubical or rounded than columnar, over the now very attenuated wall of the ovary. The detached follicles, pouches, and debris must either be extruded later or absorbed. The condition of the epithelium points to an exuviation taking place, and the gelatinous matter probably consists not only of mucin secretion but of the great mass of the cells also which have undergone mucoid degeneration.

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* "The Natural History of the Marketable Marine Fishes of the British Isles," p. 340.

The almost mature egg of the angler, separated from its gelatinous matrix, measures about 1·7mm.; it is spherical, with an extremely thin capsule, about 0·006mm. in thickness, in optical section; in mounted sections it measures only 0·004mm., and consists of a single layer. It has a specific gravity of 1034. On examination with a lower power it is semi-translucent, several oil-globules of different sizes being apparent, and numerous yolks-pherules; by reflected light it has the whitish, watery, and granular appearance of a melting snowball (fig. 5, Pl. II.). The germinal vesicle cannot be detected in these eggs in the fresh state. On rupture under the cover-glass oil droplets and yolk-spherules of various sizes pour out. A section of a piece of an ovary containing these almost ripe eggs is shown in fig. 13, Pl. II. They measure in section about 1·4mm.; the yolk-spherules have fused into large droplets here and there, which appear in section as somewhat rounded or irregularly-shaped curdled masses, mostly towards the periphery of the egg. In the centre the spherules are as a rule much smaller and more like their condition in the previous opaque stage. In some of these sections an excentric germinal vesicle, in process of degeneration, is present.

I shall now briefly describe the character of the ovarian eggs in other sections, beginning with the smallest. I have not yet attempted specially to trace the formation of the primitive ova from the germinal epithelium, but some of the appearances seen may be described. The earliest stage in the formation of the ovigerous pouch consists in a slight papillary or broadly conical elevation of the columnar epithelium covering the floor of the ovary. The space below this elevation is clearer than the subjacent tissue, and minute clear spherical cells can be seen in it, apparently arising from the proliferation of the basal cells of the epithelial layer. In larger cones one may see the loose connective-tissue stroma, which contains numerous nuclei, occupying the interior, with capillary blood-vessels and also the smaller eggs. In a section of an ovary from a fish (size unknown) captured on 5th March, preserved in platino-aceto-osmic mixture and stained with eosin and hæmatoxylin, the young ovigerous pouches are well seen. There are no traces of old follicles. The epithelial lining is well marked, and composed of a single layer of low columnar clear cells. The following features are visible with the 2mm. immersion lens of Zeiss and compensating ocular 4:—At the narrow part of the stalk of a pouch, where the epithelium becomes reflected on to the latter, the cells are somewhat irregularly heaped up, many are oval and some spherical, and each contains a small brightly-stained nucleus and a very scanty ill-defined network in quite clear unstained contents. On the sides of the pouch the cells become oval and then flattened to form its covering; but at the part where the epithelium passes from the stalk to the base or side of the pouch there is an interruption of its continuity, and minute cells are to be found under the epithelial layer. These seem to be detached epithelial cells which have insinuated themselves into this position, and they constitute the smallest ova that can be distinguished as such with certainty.

The smallest of these ova differ only in appearance from the few spherical epithelial cells above referred to in the layer at the base of the pouch in being larger and in having the scanty reticulum somewhat better defined. One measured 0·0056mm., and the highly-stained granule, or nucleolus, in the interior was not above $\frac{1}{10}$th of the diameter; the diameter of one of the round epithelial cells outside the pouch was about 0·0035mm. In those a little larger, measuring about 0·008mm. in diameter, no single prominent stained granule or nucleolus can be seen, but the network is now very obvious, though somewhat scanty, the meshes being larger and the threads very finely granular, and there are a number of minute net-knots brightly stained. In the germinal vesicle, as it may now be called, 0·011mm. in diameter, the network has obviously increased and become closer, the meshes being smaller and the karyosomes more numerous, but still minute. The general appearance of all these stages is a clear transparent vesicle with a slender network that seems in the smaller ones to be chiefly arranged against the inner surface. In some of the size stated (0·011mm.) a faint crescent may be detected, at one side in which are a number of stained granules looking like nucleoli. In eggs somewhat larger the cytoplasm consists very frequently of a crescentic cap placed at one end of the usually ovate germinal vesicle, or when the germinal vesicle is spherical it is arranged around it more regularly. For example, an egg with a germinal vesicle, 0·0168mm. by 0·028mm., was destitute of cytoplasm except at one end, where it extended 0·011mm. in a rapidly tapering cap. The wall of the germinal vesicle was very delicate and everywhere highly stained, and it contained a very dense achromatic network, towards the centre of which what seemed to be minute granules could be indistinctively perceived. The most striking difference in the germinal vesicle, as compared with the previous stage, is the presence of a few minute brightly-stained nucleoli at the periphery, the comparative absence of karyosomes, and the dense network. The cytoplasm, as in all small teleostean eggs, is very highly stained, and in these preparations it contains a large number of highly-stained particles as large as the nucleoli, the matrix, which is finely granular, being also highly stained. In eggs a little larger these stained bodies are also conspicuous; some of the larger are surrounded by a narrow clear zone, like yolk-nucleoli, and in some cases they are disposed in ball-like clusters. I have been able to trace them into the conspicuous yolk-nucleus present in eggs a little more developed. The appearance of the cytoplasm in eggs measuring about 0·12mm. shows a coarsely granular appearance, but not the presence of the definite particles described, and it is less deeply stained. The appearances in the ova above described are consistent with the growth in the germinal vesicle of the minute eggs of a dense network, the formation of karyosomic nucleoli in this network, the growth and transference of these to the periphery of the vesicle as the characteristic nucleoli, with marked achromatic appearance of the network, and their transference to the cytoplasm around. In these pouches of the angler the gradation of the depth of staining of the cytoplasm in eggs of different sizes is very well shown, the small ones at the bottom of the pouch being most intensely coloured, the depth of tint diminishing as the size increases. In the larger eggs in these sections, measuring about 0·08mm., a yolk-nucleus is distinct. With a low power it appears as a round body, more deeply stained than the cytoplasm, and surrounded by a pale zone; sometimes it is flattened out and ovate at the extreme periphery, sometimes close to the wall of the germinal vesicle; in one case it lay over the germinal vesicle and appeared to be contained within it, but as a space existed near to the margin of the latter it had probably been displaced in cutting. With moderate powers the margin of the yolk-nucleus is ill-defined, appearing to shade off into the clear zone, which is clear because of the absence of the granular protoplasm. Examined with the 2mm. oil immersion, ocular 4, it appears finely granular without definite structure.

Another feature in these eggs must be referred to. In the fresh condition, the germinal vesicle is seen to be more or less surrounded by aggregations of minute oil-globules, which are also scattered throughout the cytoplasm (fig. 10, Pl. II.). These clusters of little oily globules are conspicuous when the egg is examined with a low power (Zeiss A., oc. 2), the intervening spaces appearing clear. But when it is examined with 4mm. Zeiss apochromatic, oc. 2, the intervals are seen to be crowded with immense numbers of very minute globules, invisible under the lower power.

The outline of the germinal vesicle in these small fresh eggs is difficult to make out, and appears as a delicate line, while neucleoli could not be detected within it; thus differing from the ordinary condition seen in the pelagic ovum. In the osmic preparations the oil-globules appear as black opaque dots, or aggregations of dots (showing fusion of the globules as a rule), although they were treated in the ordinary way, and mounted in balsam. In eggs as small as 0·036mm. a few black specks may be observed. In specimens preserved in picro-sulphuric acid, vacuoles—fewer and larger—represent the position of the oil-globules.

The conditions of the germinal vesicle or cytoplasm above described were also found in sections of the ovary of a specimen 45 inches long, caught on 20th May, preserved in Perennyi's fluid, and stained with saffranin, eosin, and hæmatoxylin; as well as in sections of the ovary of a fish, 48 inches in length, caught on 9th February, preserved in picro-sulphuric acid, and stained in the same way. This ovary contained yolked eggs, and the smallest eggs present measured about 0·018mm. The yolk-nucleus is very well shown in the former series (fig. 12, Pl. II.), but yolk formation has not begun.

The only sections I possess showing the presence of yolk in the immature eggs are those just referred to, in which it is far advanced; the smaller eggs, at the base of the pouches, are pale, and more or less vacuolated at the margin. The appearance of the larger yolked eggs is shown in fig. 11, Pl. II. It will be observed that the larger spherules are placed towards the periphery, as if the growth of the cytoplasm in the eggs of the angler took place from the germinal vesicle, outwards—compare the eggs of the dory in fig. 11, Pl. III. It will also be noticed that the network of vacuolar spaces usually present around the germinal vesicle in eggs possessing an oil-globule is absent in these; the small oily droplets are probably interspersed throughout the cytoplasm, and collect at maturation. In these mounted sections the granular contents of the yolk-spherules can scarcely be detected, but they are stained intense red. In spirit preparations the spherules appear as an aggregation of solid bodies.

In the larger yolked eggs the nucleoli are very conspicuous and highly stained. They are composed of a large number of smaller spheres, vesicles, or granules. They collect at the centre of the germinal vesicle, and some of them undergo disintegration, while in the clearer central part, within the circle of nucleoli, numerous minute corpuscles or granules become arranged in chains, in the form of loops or coils. The process, as well as the changes in the germinal vesicle in more advanced eggs, is more fully explained elsewhere (see p. 108).

2. The John Dory (*Zeus Faber*).

The eggs of this fish have not hitherto been described, but the spawning period is fairly well ascertained. Holt, during the scientific survey of the fishing ground on the west coast of Ireland, found females ripe in July and August, and one spent in June.* Cunningham† also found ripe females in August, at Plymouth. The eggs, however, have not been described. Cunningham suggests that they may be of the same type as those of *Capros aper*, namely, buoyant and transparent; but an examination of the ovarian eggs does not bear this out.

I obtained the ovaries of a dory caught on 24th April, which weighed about three pounds, the ovaries weighing just a little over three ounces. Each ovary was flattened, broadly tongue-shaped, and attached to its fellow by the inner margin or base by strong fibrous tissue—that is to say, connate; it measured eight centimetres in length, and the attached margin was also eight centimetres long (fig. 8, Pl. III.). The capsule was markedly thick and tough. On cutting the ovary open, the lumen was found to be relatively very large, and the ovigerous lamellæ projected at most about one centimetre into the sac. The ovarian stroma was abundant, dense, and tough, and the largest growing eggs were about 1·3mm. in diameter. On carefully searching the lamellæ I discovered a few large eggs, obviously a remnant from the preceding spawning period. The largest of these was shrunken, the zona being wrinkled and crumpled, but by soaking it in water it was made to assume more of its normal shape. It was white and opaque-looking to reflected light, the zona showing distinct appearance of concentric lamination. On putting on the cover-glass its weight alone pressed out some of the yolk, and also globules of oil, and the egg in this condition measured 2·72mm. In optical section the capsule showed three distinct layers, and was 0·15mm. thick. Under a low power the surface of the capsule exhibited fine wrinklings, like interwoven convolutions (Zeiss A., oc. 2), and very fine apparent striations. On applying pressure to the cover-glass more oily matter exuded, and the capsule burst. The surface of the flattened membrane now appeared minutely dotted, the dots being arranged, or catching the eye, in linear order, and a high power revealed a minutely honeycombed appearance, without wrinkles. The diameter of the flattened capsule was 3·48mm. Another capsule found among the laminæ measured 2·88mm. under the cover-glass, without any pressure but its weight.

Eggs smaller in size, but still large for ovarian eggs, were found imbedded in the stroma. One of these measured 1·39mm., as taken from the ovary; immersed in sea-water it measured 1·52mm. It was white by reflected light, and quite opaque, and was still contained within the follicular investment, blood-vessels being visible on the surface. On being isolated and placed under the cover-glass the contents had a brownish appearance with transmitted light, and two separate groups of oil-globules were faintly visible—one consisting of three and the other of four larger globules, each being about 0·08mm., with numerous smaller globules, about 0·018mm., around them. Some other eggs, slightly smaller, contained a prominent oil-globule of a straw colour; thus, in an egg of 1·02mm. the globule measured 0·25mm.

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* Report of the Council, Royal Dublin Soc., p. 245. 1892.

† "The Natural History of the Marketable Marine Fishes of the British Islands," p. 322. 1896.

The eggs are so resistant that very considerable pressure is required to rupture them, behaving in this respect like most thick-shelled demersal ova, and differing from all pelagic. The larger eggs sank at once in sea-water of specific gravity 26·7 (temperature 12·6° C.). After soaking the eggs in a 2 per cent. solution of common salt the position of the germinal vesicle was indicated by a lighter circular area in the centre; it may also be shown by pressure, but not until the egg is considerably flattened.

The follicular investment of these eggs is thick, and so tough and elastic, that after the zona had been ruptured by pressure it allowed the yolk to bulge it outwards, and to strip it in some cases almost entirely from the capsule. The dense follicle is also a point in which the ovarian eggs of *Zeus faber* differ from ovarian eggs that become pelagic. The flattened capsule had a thickness of 0·058mm. in these half-grown eggs, and the double layer of which it is composed was well marked. It is shown in section in Plate III., figs. 10, 11.

It is, however, in the yolk that the demersal character of these eggs is perhaps most apparent. The yolk does not flow from a rupture in the capsule in the fluid manner that it does in the opaque stage of pelagic eggs; it escapes from a small orifice as a coherent column or ribband, only semi-fluid or jelly-like, and it consists of a protoplasmic matrix, in which solid-looking bodies are imbedded. These bodies are the yolk-spherules, which in the fresh condition are not all spherical, but as a rule somewhat irregular in shape. The larger ones measure from about 0·04 to even 0·10mm., and they take on a deep stain (Plate III., fig. 10). With a moderately high power two forms of small spherules can be distinguished—(1) oily-looking and refringent, showing optical concentric lamination; (2) true yolk-spherules, not very refringent, and full of minute dark, almost black, granules. In mounted sections they appear like mulberries. Besides these, numerous larger oil-globules are contained in the cytoplasm.

The opaque yolked eggs ranged in size from the large ones described down to about 0·35mm.; smaller ova, destitute of yolk, were present in considerable numbers, and others in which the deposition of yolk at the periphery had just begun (fig. 9, Plate III.). Before any yolk is formed oil-globules appear for the most part in the protoplasm immediately around the germinal visicle, which is thus obscured; this condition may be observed in eggs as small as 0·16mm., in which an envelope, or zona, is formed (fig. 2, Plate III.). By pressure under the cover-glass the dark ring or shell of oil-globules may be made to travel with the germinal vesicle towards a rupture in the capsule, where they become detached in little clusters and escape. In mounted sections prepared in the ordinary way the oil-globules are dissolved, their position being indicated by empty spaces (figs. 9, 10, 11, Plate III.). Thus the germinal vesicle appears to be surrounded in such sections by a vacuolated zone.

The germinal vesicle exhibits the usual characters found in the ovarian egg of Teleosteans. The nucleoli are conspicuous and highly stained, some of them showing a central brighter area or vacuole (fig. 12, Plate III.). In some cases the central part of the germinal vesicle contains chains of minute stained spherules, or chromosomes, resembling those seen in the advanced eggs of the angler (see p. 103, Plate III., figs. 12, 14).

Sections were made of the ovary of another fish, 20½ inches in length, caught on 22nd July. In this specimen the eggs are not so far advanced, the larger being about 0·45mm., and numerous old follicles, like those described by Cunningham in the ovaries of the plaice and gurnard,* were present.

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* *Quart. Journ. Micr. Sci., Vol.* xl., p. 114, 1897.

From the above observations it would appear that the mature eggs of the John Dory are large, probably ranging between 2·5 and 2·8mm., that they contain one or more oil-globules, and are demersal. The demersal nature is indicated by the comparatively dense fibrous tissue of the stroma and follicle, by the thickness of the capsule and the presence of a well-defined double layer, by the character of the yolk, especially of the spherules, and by the general hardness and resistance to pressure. In all these features it contrasts with ovarian pelagic eggs.

The condition of the eggs, as regards their degree of development and the large empty cavity in the ovaries, points to the spawning period being some months later than April.

EXPLANATION OF PLATES.

PLATE II.

Fig. 1.—Ovaries of the Angler *(Lophius piscatorius)*, 29 feet long, extracted in February from a female 4 feet 2 inches in length, containing almost ripe eggs (shown in fig. 13); *a a*, delicate membranous mesovarium; *b*, oviduct. Scale—half an inch to a foot. (The distribution of the blood-vessels is to a large extent diagrammatic.)

Fig. 2.—Central part of the same, showing the junction of the two ovaries and the oviduct. Part of the thin, barren wall of the ovary has been cut away to show the inner surface of the ovigerous wall—the ovigerous pouches are represented as circles in the gelatinous matrix; the distribution of blood-vessels exactly shown. Scale—2 inches to a foot.

Fig. 3.—Part of same ovary from which a piece of the barren wall has been removed, showing the ovigerous pouches projecting into the gelatinous matrix. Enlarged.

Fig. 4.—Cross-section of the same ovary showing the germinal wall, with the egg-pouches arranged in a single layer, and embedded in the matrix; the barren membraneous wall has been raised by a hook. (Slightly diagrammatic.) Scale—6 inches to a foot.

Fig. 4*a*.—The same, showing the junction of the ovigerous and non-ovigerous walls. Enlarged.

Fig. 5.—Nearly mature fresh egg of the Angler removed from the gelatinous matrix, showing oil-globules and yolk-spherules. Enlarged. (The capsule is represented too thick.)

Fig. 6.—Surface view of the epithelial mucin-secreting cells covering the outer surface of the ovigerous pouches. Magnified.

Fig. 7.—An ovigerous pouch containing a mature egg, torn across at its base and removed. From a spirit preparation. Enlarged.

Fig. 8.—Cross-section of part of an immature ovary of an Angler, 27 inches in length, caught on 22nd November; preserved in picro-sulphuric acid, and stained with hæmatoxylin and eosin, showing the junction of the barren and ovigerous walls, the splitting of the latter, the protrusion into the pouches, &c. Magnified.

Fig. 8*a*.—Part of the barren wall of same, exhibiting the columnar epithelium. Magnified.

Fig. 9.—Cross-section of part of an immature ovary of an Angler, 30 inches long, caught on 21st May, preserved in Perennyi's fluid; showing same features as in Fig. 8. Magnified.

Fig. 10.—Small egg of Angler, in the fresh condition, measuring 0·02mm., showing the clusters of oil-globules around the germinal vesicle.

Fig. 11.—Section of advanced ovum of Angler, 0·9mm. in diameter, from the ovary of a fish, 48 inches long, caught on 9th February. Preserved in picro-sulphuric acid, and stained with hæmatoxylin, saffranin, and eosin. *a*, Membrana propria folliculi.

Fig. 12.—Section of eggs from the ovary of an Angler, 45 inches in length, caught on 20th May, showing yolk-nucleus in two contiguous eggs. Preserved in Perennyi's fluid, stained as before.

Fig. 13.—Section from the ovary shown in figs. 1 to 4, showing the mucoid secretion, the partial fusion of the yolk-spherules in the almost ripe eggs, &c.; *g.v.*, germinal vesicle in process of disintegration (see fig. 4, Plate III.), the nucleoli breaking up into granules; *y*, yolk partially fused; *m*, mucoid secretion; *s.e.*, mucin-secreting epithelium; *w.o.*, greatly attenuated wall of ovary; *d.o.*, degenerating ova at base of pouches; *fo.*, follicle. Preserved in picro-sulphuric acid, stained with hæmatoxylin, saffranin, and eosin.

Fig. 14.—Section of ovary from which Fig. 11 is taken, showing the arrangement of ovigerous pouch; *a*, large ovum represented in outline; *b*, base of pouch showing the upward protrusion of sub-epithelial tissue; *w.o.*, wall of ovary; *s.e.*, mucin-secreting epithelium.

PLATE III.

Fig. 1.—Section of ovary of Angler showing arrangement of pouches, from somewhat stale material; preserved in picro-sulphuric acid, stained with borax-carmine. Magnified 50 times. *a*, Columnar epithelium.

Fig. 2.—Small fresh egg of *Zeus faber*, showing the peri-nuclear zone of oil-globules.

Fig. 3.—From the same sections of ovary of Angler as Fig. 11, representing the epithelial cells near the base of a pouch. Zeiss 2mm. oil immersion, comp. oc. 4.

Fig. 4.—Germinal vesicle of the central ovum in the Angler in fig. 13, Plate II., showing its disintegration at the inner surface of zona radiata, fusion of contents with scanty cortical layer of protoplasm, and the vacuolation and breaking down of the nucleoli into spherical granules. 2mm. Zeiss oil immersion, comp. oc. 4.

Fig. 5.—Germinal vesicle of ovum of Angler, represented in fig. 11, Plate II., showing the disintegration of the nucleoli, the chromosomes or tangle in the centre, and chromatin granules dispersed throughout its substance. *a*, Nucleolar shell; *b*, granular bodies. 2mm. Zeiss immersion, comp. oc. 6.

Fig. 6.—Germinal vesicle of egg of Angler, from section shown in fig. 12, Plate II. 2mm. Zeiss immersion, comp. oc. 4.

Fig. 7.—Peripheral portion of germinal vesicle of an egg of Angler, from same ovary as fig. 4, showing breaking down of nucleoli, the chromosomes or tangle, and free chromatic granules, stained with eosin, rubin, and orange. 2mm. Zeiss, comp. oc. 6.

Fig. 8.—Ovaries of *Zeus faber*. Reduced.

Fig. 9.—Section of egg of same, showing fused oil vacuoles and granulated cytoplasm. Preserved in picro-sulphuric acid, stained with hæmatoxylin, saffranin, and eosin.

Fig. 10.—Larger egg of same.

Fig. 11.—Egg of same, showing oil vacuoles, yolk-spherules, and layers of capsule.

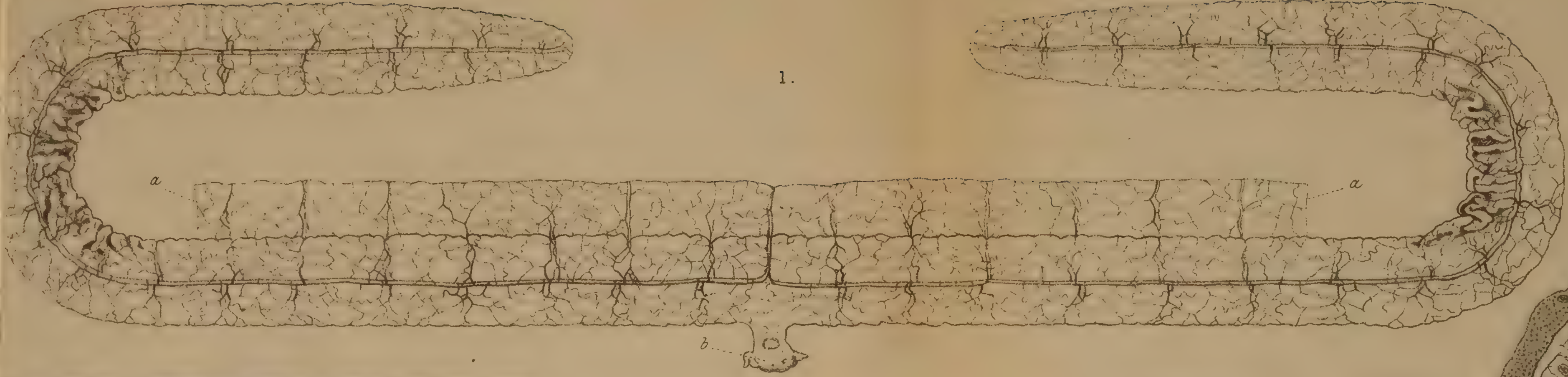
Fig. 11*a*.—Yolk-spherules of same.

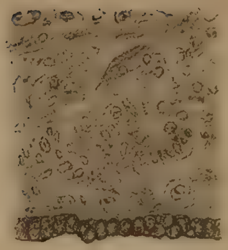
Fig. 12.—Germinal vesicle of ovum represented in last figure, showing chromosomes.

Fig. 13.—Section of ovary of same, showing capsule and arrangement of eggs.

Fig. 14.—Germinal vesicle of egg, same size as fig. 10, showing chromosomes nucleoli, and free chromatic granules. 2mm. Zeiss oc. 4.

Pl. II.





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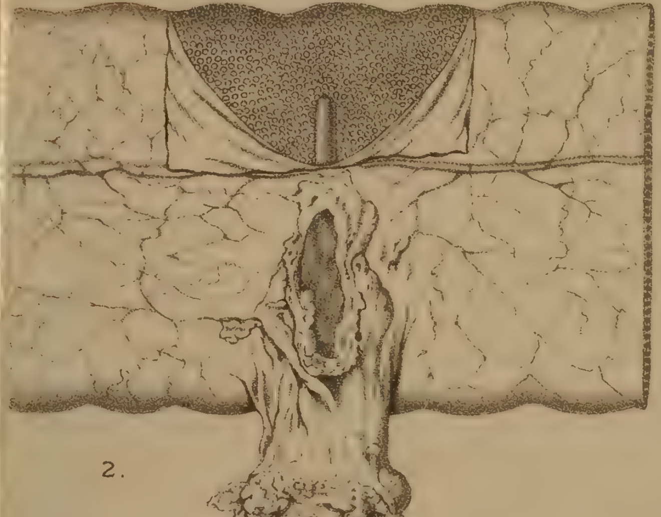

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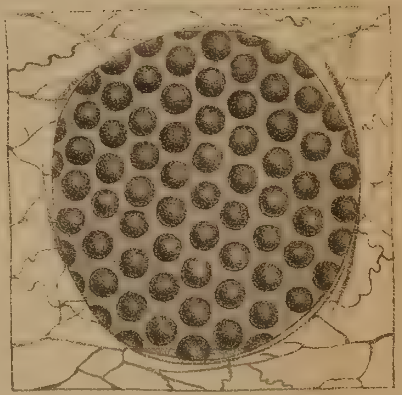

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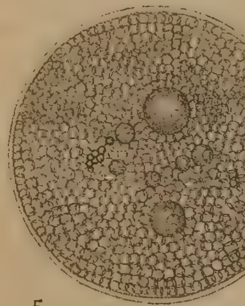

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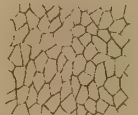

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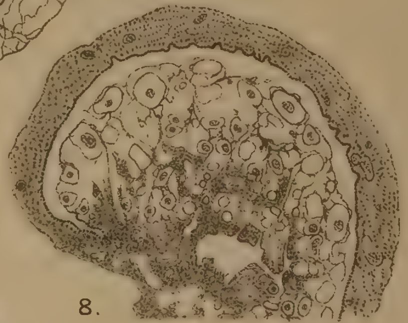

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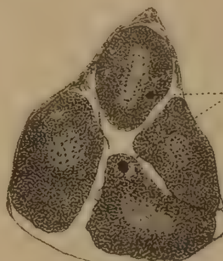

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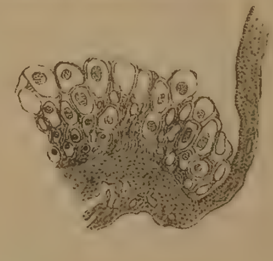

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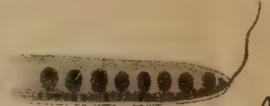

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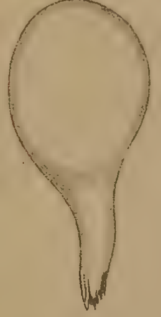

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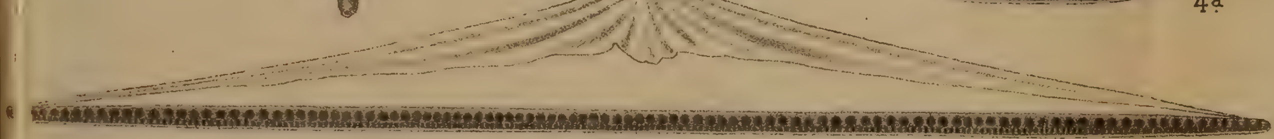

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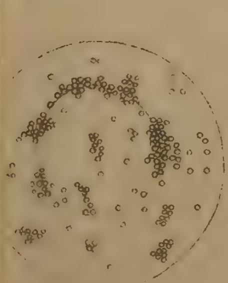

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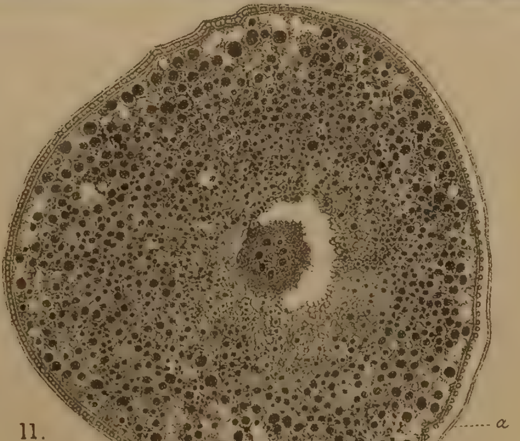

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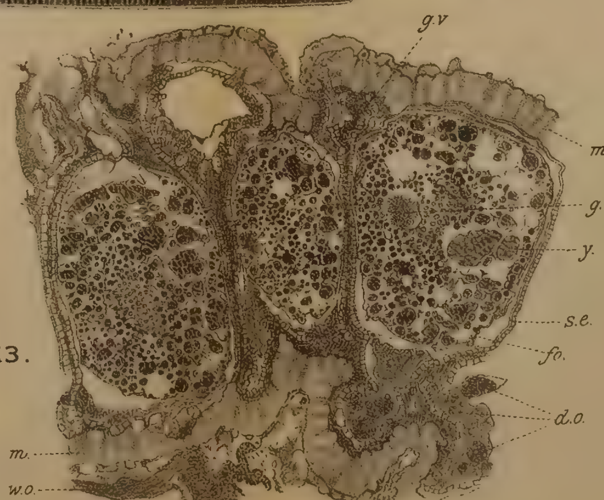

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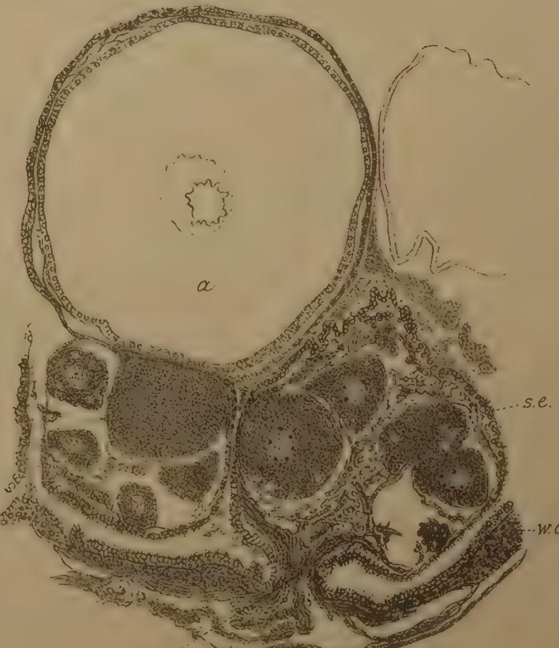

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G. Figs 1-4, 8, 9, 11-14.
N.P. „ 5-7, 10.

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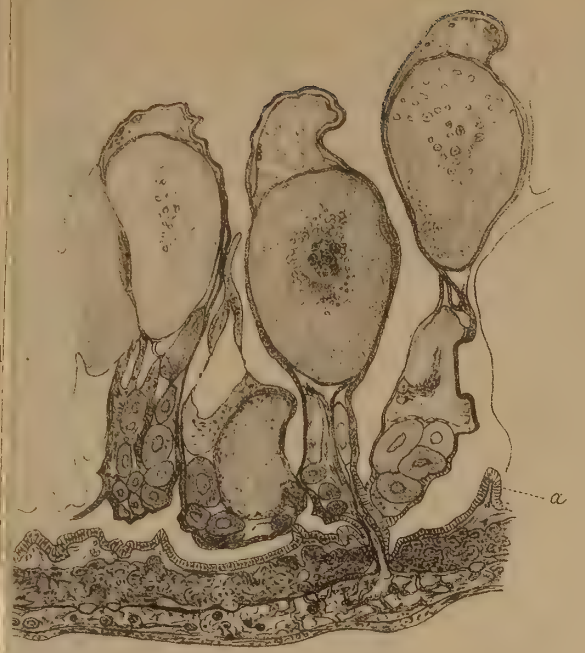
Pl. III.



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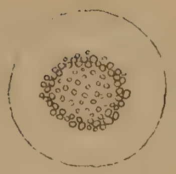

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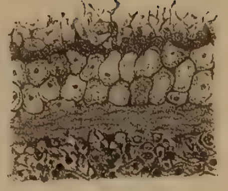

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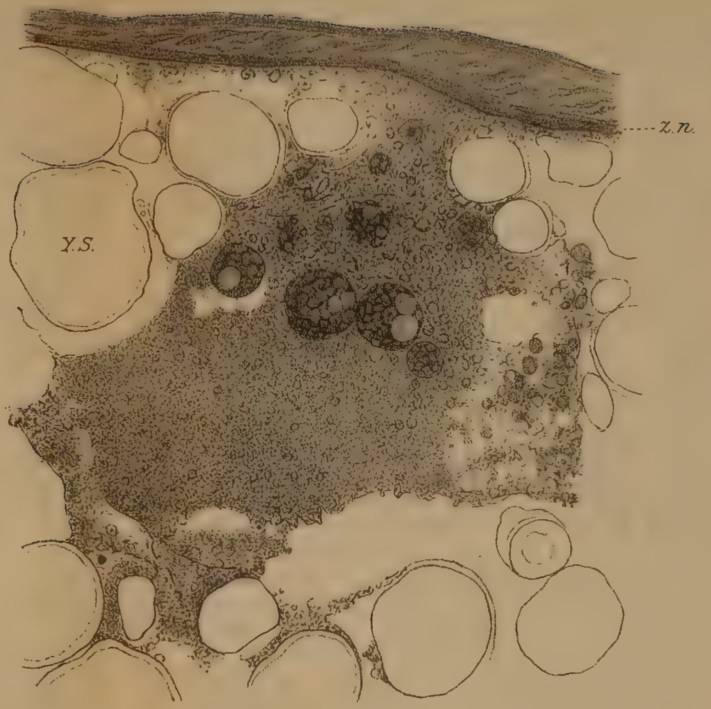

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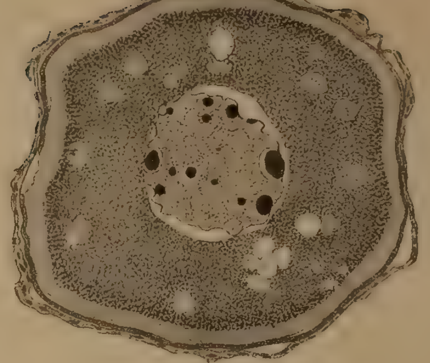

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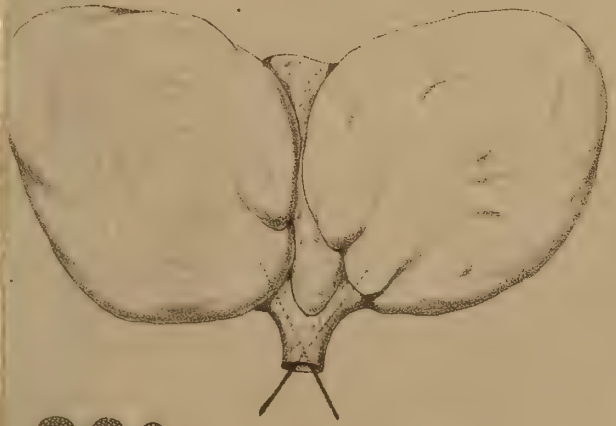

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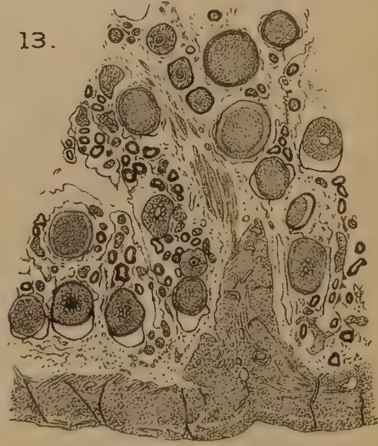

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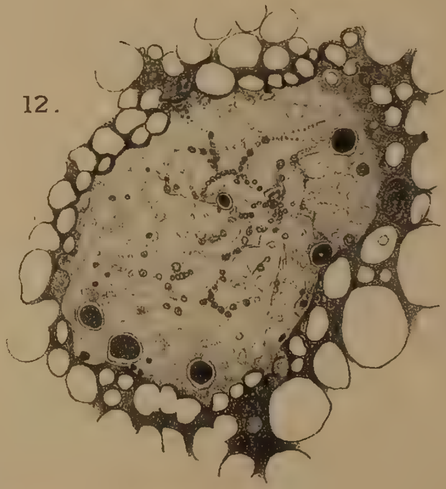

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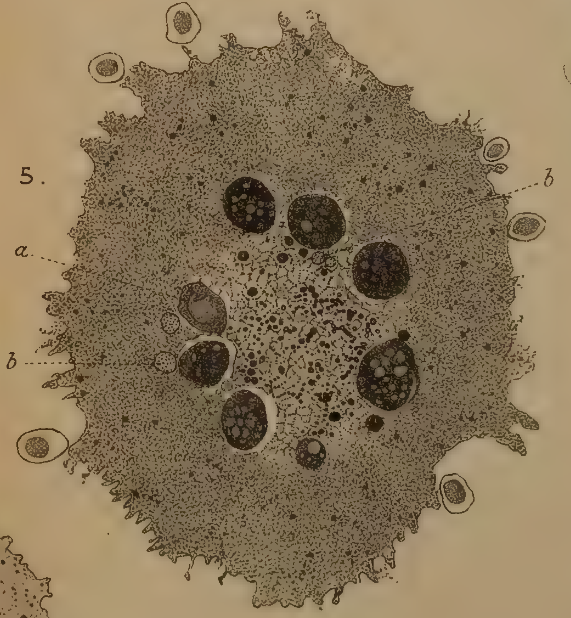

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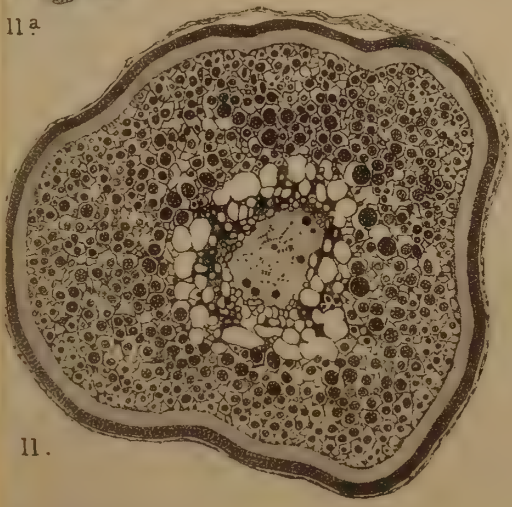

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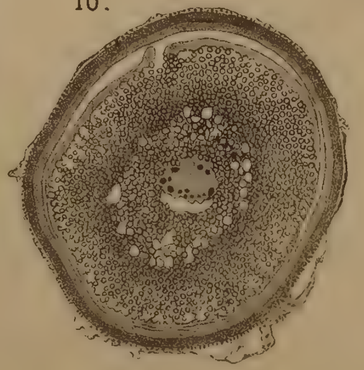

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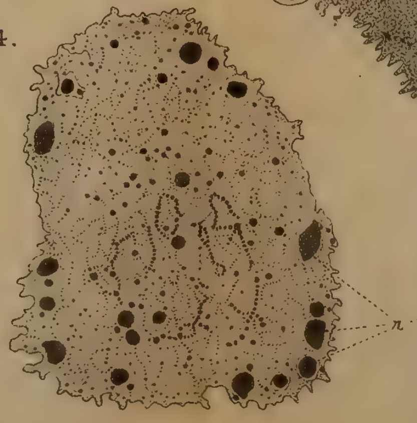

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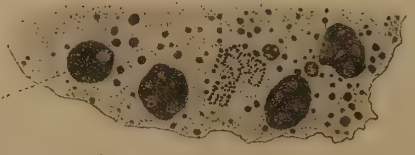

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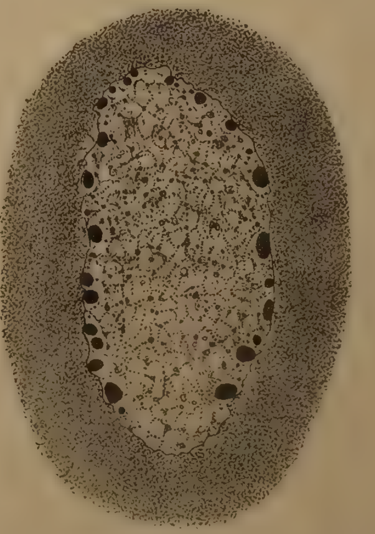

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IV.—THE PHYSICAL AND CHEMICAL CHANGES TAKING PLACE IN THE OVA OF CERTAIN MARINE TELEOSTEANS DURING MATURATION.

By T. H. Milroy, M.D., B.Sc., Assistant to the Professor of Physiology, University of Edinburgh.

INTRODUCTION.

At the beginning of last summer (1897) I was requested by the Fishery Board of Scotland to continue some investigations which I had commenced at the suggestion of their Scientific Superintendent, Dr. T. W. Fulton. These investigations specially dealt with the alterations in specific gravity which the eggs of the plaice undergo during maturation, and also the changes in the water percentage in the same ova as ripening proceeds. I also examined at that time one or two specimens of ovarian fluid, in order to find out their composition. This research deals simply with the subject from the physico-chemical side, and leaves the histological untouched, this latter part having been carefully worked at by numbers of scientists. In the very unripe ova of such marine Telosteans as the plaice, cod, haddock, one can easily make out the tunica granulosa cells outside and within the ovum, composed of its vitelline membrane, enclosing the vitellus in which the germinal vesicle lies. In the immature ovum this vesicle is very large, and centrally placed, and the protoplasm around it varies from a finely to a coarsely granular state. When the final stage of maturation is reached, a marked distention of the egg occurs, and this increase in volume is accompanied by a clearing up of the contents of the ovum, and the disappearance of the germinal vesicle.

These changes occur both in pelagic and demersal ova, only, in the latter, they are not so marked, the eggs appearing, even when mature, not so clear as the corresponding ripe pelagic ones. The distinguishing character of the demersal ovum, as contrasted with the pelagic one, is, of course, the higher specific gravity, the ripe demersal ovum sinking while the ripe pelagic one floats in sea water. I have purposely described the changes in the most general way, as in studying the subject from the chemical side one can only hope, at least at first, to map out roughly the essential nature of the maturation process.

Chemical Composition of the Ovum.

Before I go on to speak of the methods which I employed during the research, perhaps it would be advisable for me to run shortly over some of the most important points in connection with the chemical composition of the ovum, so far as it is known at the present day. In the egg there are, as in all living cells, the two great constituents, protoplasm and nucleus, with, in addition, that structure of secondary importance—the cell wall. In the first place, I shall discuss the nature of the protoplasm.

PROTOPLASM.

One must distinguish the small amount of protoplasm in the primordial egg from the larger amount of nutritive yolk present in the egg at later stages. The former is the formative or germinal protoplasm, the latter the nutritive yolk. One must not, however, forget that the latter is not to be regarded as simply nutriment to be burned up, but building material which, by gradual transformation, is changed into the formative protoplasm; or, rather, some of its constituents pass from the nutritive yolk to the germinal protoplasm. In it are present the forerunners of the organised substance of the germinal protoplasm. The interchanges in the ovum during growth take place between nutritive and formative protoplasm, and then between the latter and the nucleus. The specific gravity of the nutritive yolk and formative protoplasm varies. In some cases the latter is of lower specific gravity, so that the nutritive yolk takes the lower position when the germinal disc is formed. In many cases, however, the germinal disc is of higher specific gravity, as in the ova of the marine Teleosteans, where it is situated, along with the micropyle, at the lower pole. Before the germinal protoplasm is collected into one mass, to form the germinal disc, it may be seen in many ova as a fairly well-marked zone around the vitellus, in the outer part of the egg. This is very well seen in the ovum of the cod.

The consistence of the yolk alters in different ova, from solid yolk-plates in the cyprinoids to a fluid of a watery nature in the teleostean ova. Both are, however, of essentially the same chemical composition. If you add to the vitelline fluid of the salmon ovum acetic acid, you at once get a precipitate of a flocculent type, easily soluble in excess of the re-agent. This precipitate contains phosphorus organically bound. On pouring the vitelline fluid into distilled water, a precipitate of the same nature is obtained. It is a nucleo-albumin, containing in it a body only with difficulty attacked by the peptic ferment of the gastric juice. This body is attached to the albumin. It has been carefully studied in the case of the vitellus of the hen's egg. It is a paranuclein, that is to say, a body similar in some of its characters to the true nucleins which occur in the nuclei of some cells. *e.g.*, pus cells. It contains phosphorus organically bound, and is only slowly attacked by pepsin, like the true nucleins; but, unlike those, it does not furnish nuclein bases on decomposition with acids. The yolk-plates, which have been described so frequently as occurring in different fish and amphibian ova, were at first regarded as composed of fat. Johannes Müller, in 1842, said that these plates were soluble in boiling alcohol and ether, leading him thus to believe that they were of a fatty nature. Virchow, however, in 1850, showed that, in addition to fat, they contained a substance which gave proteid reactions. In 1854 Valenciennes and Frémy cleared up the subject much more than the previous writers. They separated the plates in a pure condition, and showed that they were of a proteid nature, but thought that they differed from the ordinary albuminous substances by giving no violet colour with hydrochloric acid. A point of far greater importance was that they were found to contain phosphorus in comparatively large quantity, and organically bound. From the yolk-plates of different varieties of ova they obtained proteid substances, which differed in slight particulars from one another, and so they gave several names to these, *e.g.*, ichthin, ichthidin, emydin. These substances are of the greatest importance physiologically, as being the first of the tissue-forming bodies to be prepared pure. For a long time it was supposed that they owed their phosphorus percentage to an admixture with lecithin, although those who held this opinion might have seen how erroneous it was if they had read Valenciennes and Frémy's paper, where it is stated that the percentage of phosphorus remained high (3 per cent.) even after prolonged extraction with warm alcohol and ether. Lecithin is always found with it, but can be removed in the way above described. Miescher found these plates in the eggs of Bombinator, and showed that in every hundred parts of the yolk-plates, sixteen were composed of lecithin. Miescher noticed also that the ash, after incineration, of this substance reacted acid, that is to say, phosphorus had been present in organic combination, not bound to bases. He also was the first to show that, after gastric digestion of the plates, an insoluble residue, containing phosphorus, was left; and, from his examination, he thought he was dealing with a nuclein similar to that present in the nuclei of pus cells. It differs from these true nucleins in, as I have said before, not furnishing nuclein bases. The other constituents present in the yolk are fat, lecithin, albumin, inorganic salts, organic salts, cholesterin, pigments, and water.

Nucleus.

The nucleus, or in the case of the ovum, the germinal vesicle contains different albuminous substances, which are mostly characterised only by their affinity for certain stains. The chromatin of the histologist has been supposed to be identical with the nuclein of the physiological chemist, and has always been referred to as the important constituent of the nucleus. It is a phosphorus-holding albuminous substance, which is very resistant towards action of pepsin. It is characterised by the fact that on decomposition it furnishes nuclein bases. It is composed of an organic acid which contains all the phosphorus of the nuclein—nucleic acid—bound to more or less albumin. In the condition of mitosis, the organic phosphorus-holding acid, nucleic acid, is supposed to exist in the free state; but all our evidence in support of this is based simply on staining affinities of the acid, and is not conclusive.

I do not believe that this true nuclein is present in the germinal vesicle of all resting ova, except in very small quantity. In fact, even when I have used large quantities of immature ova, I have been able to obtain it only in small amount. But when the ovum is fertilised true nucleins soon appear. Whether formed from albumen, or added on by the male pronucleus, I do not know. The subject still requires investigation. The paranuclein or pyrenin of the histologists is not definitely characterised, either histologically or chemically. Linin (Schwarz) is also an exceedingly indefinite body, as also Zaccharias' amphipyrenin, the substance present in the nuclear membrane.

Vitelline Membrane.

The vitelline membrane is of a proteid nature, and is secreted by the ovum itself.

Reaction of Yolk.

All specimens of yolk which I have examined react acid when fresh, but if one incinerate the fluid, the ash which is obtained reacts alkaline; that is to say, the acidity is due to an organic acid, probably lactic acid.

The description of the changes which take place during maturation of the ovum with regard to the entrance of substances from without, and their passage to different parts of the ovum, I shall give later, when I have run over shortly the changes in specific gravity, etc., of the ova as ripening proceeds.

PHYSICAL AND CHEMICAL CHANGES IN THE OVA OF SOME MARINE TELEOSTEANS DURING MATURATION.

The well-known changes during maturation of a pelagic ovum are the increased transparency of the yolk contents, the lowering in specific gravity, and the disappearance of the germinal vesicle. In the demersal ovum the same changes occur, only the processes do not go on so far. That is to say, the egg does become less opaque, of lower specific gravity, and the germinal vesicle disappears. Why and how do these changes take place? The increase in volume has been calculated by Dr. Fulton in a variety of ova, and I need only refer to his paper for a discussion of this subject from the histological standpoint. At his suggestion I investigated the subject from the more purely chemical side. Such questions as the following came up for solution:—Does the maturation of pelagic and demersal ova take place along the same lines? That is to say, does the composition of the pelagic and demersal ova alter in the same way as ripening takes place? What is the cause of the increased volume and transparency, and the diminished specific gravity of pelagic ova, and is the change in the demersal eggs of the same type, only lesser in degree? Where do the constituents of the ovum come from, and how are they produced when the increase in volume takes place during ripening?

I shall divide up the work into the following sections:—

(1.) A description of the methods employed during the research.

(2.) Changes in volume, specific gravity, and percentage of water in different pelagic and demersal ova during maturation.

(3.) Nature of the changes in the solids, *e.g.*, albumins, nucleo-albumins, chlorides, fat, and lecithin.

(4.) Composition of ovarian fluids.

(5.) The *rôle* of the phosphorus in maturation.

A.—METHODS USED FOR DETERMINATION OF SPECIFIC GRAVITY.

I. *Of the ovarian fluid, from unripe and ripe roes.* This gave no difficulty. The method was simply weighing by means of the piknometer. The piknometer was weighed empty, full of distilled water, and then full of fluid to be examined, *e.g.*, Wt. of Pik. alone = P, P. + water = P^1, P. + fluid = P^{11}; thus $\frac{P^{11} - P}{P^1 - P}$ = sp. gr. of fluid.

II. *Of the unripe and ripe ova.* This was more difficult, and in many cases the results were not wholly satisfactory. Four methods were employed:—

(1.) By means of the piknometer. This is by no means a suitable method, as it is impossible in many cases to get the vessel, after filling it with ova, free from air bubbles. However, in the case of some unripe eggs it was carried out, but the results were never taken alone, but compared with those obtained by one or more of the other methods.

(2.) By measuring the ova with the ocular micrometer, then calculating the volume, presuming the eggs to be spherical from the formula, $\frac{4}{3} \pi r^3$ ($\pi = 3{\cdot}1416$). Then a fixed number of ova (fresh) were weighed. Knowing the weight of each ovum, and having calculated the volume of each, the specific weight, of course, is easily obtained.

This does not give good results. In the first place, because the eggs, in most cases, are not complete spheres; and, secondly, in the measurement they become flattened out as they lie on the slide. However many you calculate the diameter of, you are not in a position to accurately determine the volume.

(3.) The method of taking the specific gravity by floating the eggs in a series of vessels containing NaCl. Cl. solution of different specific gravities was employed. A large number of vessels was taken, and each was filled with salt solution of fixed specific gravity (this was noted down on a label affixed to jar). Then ova were dropped into each of these dishes, and those two vessels in which the ova could just float and just sank were noted, and between those two a further series of observations was made by dropping in more ova. The specific gravity of the fluid, which could just support the ova, was taken as the correct one for the ova. This is a good method, only is open to at least one fallacy—viz., that as the ova lie in the fluid osmosis takes place between salt solution and contents of ova; and hence, if some time elapse between the putting in of the ova and the determination of their specific gravity, some gradually sink, or some which have sunk may rise. In the extremely interesting case of the angler fish (*Lophius*), it is not the specific gravity of the ova *per se* that is of importance, but that of the ova imbedded in the jelly-like interstitial matrix, as it is in that form that the roe is spawned.

(4.) The fourth method is one which may be termed estimation of specific gravity by displacement. It is only practicable with bodies that are insoluble in water. The ova are certainly not soluble, at least to any appreciable extent, in water during the short time in which the determination is being made.

It is carried out in the following way:—A piknometer is weighed filled with distilled water; then a quantity of the ova, sufficient to fill the greater part of the piknometer, is weighed between a pair of well-fitting weighed watch-glasses connected by a clip, the weight being carefully noted. Now all these ova are carefully dropped into the piknometer, when they fall to the bottom and displace an equal volume of water. The stopper is replaced on the flask, and the surface dried. Now the piknometer is weighed again. The specific gravity is, of course, now easily estimated, thus:—If $w = $ wt. of ova, $W = $ wt. of pik. + water, $W^1 = $ wt. of pik. + water (not displaced by ova) + w, then Sp. Gr. $= \dfrac{w}{W + w - W^1}$

This, I think, is the best method of the four described, and most of the estimations have been done by it; in fact, all have been controlled in this way.

B.—Calculation of Diameter of Ova.

This was done by means of a Zeiss ocular micrometer, the value of the divisions in it being fixed by means of a stage micrometer. An average was taken for a large number of ova.

C.—VOLUME OF THE OVA.

This was obtained either by calculation from the diameter or by estimating the volume of the water displaced by a known number of ova. I have omitted giving the volumes of the ova, as they are fully given in Dr. Fulton's paper.

D.—WEIGHT OF THE OVA.

This had to be done very carefully. The ova were freed from adherent tissue or fluid, numbered, placed between weighed watch-glasses with clip to lock them together, and then weighed in Sartorius balance. This was done as quickly as possible, so that drying of the ova might be avoided. A better method, and one which I employed also, was to weigh out two portions of ova, put one set into alcohol, and after the ova had lain for some time in the alcohol they were numbered. Knowing the weight before putting into alcohol, and now knowing the number, you knew the weight of each fresh. In this way you knew the weight and number of the ova in the other portion which can be weighed and dried.

E.—PERCENTAGE OF WATER IN THE OVA.

The ova, after being weighed as described under D., were placed in a drying oven, and kept first of all at temperatures varying from 80° to 90° C.; then the temperature was gradually raised until it reached finally 105° to 110°. They were kept at this temperature until of constant weight. The loss of weight gave the amount of water in each ovum, and, of course, the percentage was easily calculated.

F.—PERCENTAGE COMPOSITION OF THE OVA.

Of the solids of the ovum after driving off the water, the most important are the nitrogen and phosphorus holding bodies, the fat and salts. It would require much more time than I had at my disposal to make a complete analysis of all the ova sent me, so that in many cases I had to limit myself to the nitrogen and phosphorus. From the amount of nitrogen we can roughly calculate the probable amount of albumen, if such bodies as lecithin and nitrogen-holding salts can be excluded.

The nitrogen was estimated by the well-known Kjeldahl method, all the nitrogen-holding substances having their nitrogen transformed into $(NH_4)_2\ SO_4$, and from this the ammonia distilled off and estimated.

The phosphorus was estimated by Kjeldahl-Weibull method—that is, incineration of the ova with $Cn\ SO_4$, $K_2\ SO_4$, and $H_2\ So_4$; and the phosphate found estimated by the Ammonium-Molybdate method, the P. being weighed as magnesium-pyrophosphate, and phosphorus reckoned from it.

Fat was estimated by extracting the dried and weighed ova by ether in Soxhlet's apparatus until no more weight was lost, and then the ova were finally extracted for some hours with boiling alcohol.

The loss in weight which the ova underwent gave one the amount of fat and lecithin present, or the amount of residue obtained after removal of the ether and alcohol by distillation gave the fat and lecithin present. Having estimated the amount of lecithin (in the way I shall next describe), you get the amount of fat by subtracting the amount of the former from the combined weight.

Lecithin.—The alcohol and ether extract containing the lecithin was evaporated to dryness by distilling off the alcohol and ether, and the phosphorus of the residue was estimated. Amount of phosphorus × 7·2703 = lecithin (stearic acid form).

The residue was tested for cholin and for the fatty acids.

As the clearing up of the egg contents might not simply be due to the endosmosis of water, but of neutral salts such as NaCl., or acid salts such as $Na H_2 PO_4$, the amount of NaCl. present was estimated in the ash of the ova by Mohr's method—that is to say, the chlorides were estimated with a $AgNO_3$ solution, each CC of which was equal to 10mgm. of NaCl.

The acidity was estimated by extracting the pounded ova with water (dist.), squeezing out the fluid after filtering through muslin, and then titrating with one-fifth normal NaOH.

In some cases (and this will be repeated later) the ovarian fluid was examined carefully, especially for NaCl., albumin, acid salts, in addition to the specific gravity being taken.

The same methods were employed as have been described in the preceding pages.

CHANGES IN PELAGIC AND DEMERSAL OVA OF MARINE TELEOSTEANS DURING MATURATION.

I.—Change in Volume.—A. *In Pelagic.*

Dr. Fulton, in a thesis presented for M.D. degree in Edinburgh University, gave a list of the volume of the ova of different fishes in the immature and mature conditions. They were based upon the calculation of the volume from the diameter of the ova, presuming that the latter were complete spheres. To avoid as far as possible the fallacy of individual differences in form, Dr. Fulton based his calculations upon the average diameter of thirty or more ova. I have calculated the volume of a number of the same ova and of some other varieties. The increase in volume of the better-known marine Teleosteans, from the opaque immature to the transparent or translucent mature ova, varies from about 1 : 3 to 1 : 5.

The most marked increase in the volume of the ovum during ripening occurs in the egg of the plaice, where the ripe egg is fully five times larger than the unripe. In fact, in some that I have examined the ripe was six times larger than the unripe.

B. Demersal.

This increase in volume is common also to the demersal eggs, the most important variety being the herring. I give here the result of a number of measurements of these ova :—

	Volume.
Unripe, ...	1·022 cub mm. — 1·0226
Ripe, ...	2·132 „

Here the increase in volume is much less than in any of the pelagic ova. In *Cottus scorpius* the ripe eggs have a volume of 4·188 cub. mm.; the unripe eggs I have not examined.

In *Cyclopterus lumpus* (Lumpsucker) the ripe eggs have a volume practically the same as those of *Cottus scorpius*, viz., 4·18 cub. mm. Here also I have not examined the unripe ova.

The ova of *Lophius piscatorius* may be perhaps regarded as a class distinct from the ordinary demersal ova. When immature they have a volume of about ·268 cub. mm., when mature 4·18 to 5 cub. mm. Those eggs are of especial importance, as they are examples of ova which are dependent for their floating capabilities not on their specific gravity but on that of the gelatinous sheet in which they are imbedded.

Now what is this change in volume due to? To answer this question one must find out to what extent the specific gravity is diminished as the volume increases; the difference in the percentage of water in the unripe and ripe ova; and lastly, the difference in the nature of the solids in the two conditions. First of all, the alteration in specific gravity must be studied, and I shall take up first of all the pelagic ova.

Changes in the Specific Gravity of Pelagic Ova during Maturation.

In order that the eye may rapidly note the differences in specific gravity, I have arranged the results in tabulated form.

Pelagic Ova.	Immature.	Mature.
Plaice, ...	1·084	1·024–1·025
Turbot, ...	1·070	...
Saithe, ...	1·046	1·023
Whiting, ...	1·068	1·024
Cod, ...	1·055	...
Haddock, ...	1·080	1·020
Brill, ...	...	1·025
Flounder, ...	...	1·024
Ling, ...	...	1·022

In the plaice ovum, just before the final distension, the specific gravity was found to be 1·027. The immature ova given in above Table were very immature. The Sp. Gr. gradually diminishes as ripening proceeds, but it is in the final stage that the change is most marked.

Demersal Ova.	Immature.	Mature.
Herring, ...	1·087–1·090	1·066
Lophius piscatorius—		
(*a*) The ova, . . .	1·045	1·034
(*b*) „ in their gelatinous sheet, ...	1·009	1·005
Cottus scorpius, . . .	...	1·060
Cyclopterus lumpus, . .	...	1·057

In the different varieties of pelagic ova the specific gravity of the fully ripe eggs is always decidedly below that of the sea water. The results obtained by Hensen are lower than mine, probably because his calculations were based on his measurements of the volume of the ova from the diameter. I think that the displacement method which I employed is a better one. In the fully matured demersal ovum the specific gravity is always decidedly above that of the sea.

From observations that I have made in different specimens, it seems that all through the process of maturation there is a gradual decrease in the specific gravity, although it is during the final stage that the attention is most attracted to this well-marked alteration.

Now we have seen that in both demersal and pelagic ova the specific gravity is diminished while the volume is increased. And now we have to find out what this is due to. In order to do so, the first thing to settle is the percentage of water in the ripe and unripe eggs.

CHANGES IN THE PERCENTAGE OF WATER IN DIFFERENT VARIETIES OF OVA.

Is the transparency of the ripe pelagic egg simply due to an increase in the water present, or is it due to a qualitative alteration in the nature of the constituents, or is it possibly due to both these conditions? If you place a clear ripe pelagic ovum in fresh water it becomes after some time white and opaque; the same occurs in salt water if the ova are not allowed to come in contact with a pure supply of the water, as, for example, if they are crowded together or if dirt of any kind has got into the water. We know that the vitellins are kept in solution by weak salt solutions and are precipitated by the addition of water as a whitish precipitate. May the opacity of the ovum that occurs on prolonged contact with water not be due to, first, a passage of salts from the ovum outwards, and secondly, a passage in of water poorer in salts, until equilibrium with regard to salt percentage is established, with a consequent precipitation of the vitellin due to the substance which keeps it in solution having been partly removed? Does any nitrogen-holding body pass out? In order to put this matter to the test, one might carry out the following experiment:—

Take a known amount of ova (ripe), the water and total solids, salt and N percentage of which are known, and place them in distilled water. After some time has elapsed remove the ova, dry their surfaces, weigh them, dry and estimate water, salts and N. Examine also the distilled water as to reaction, salts and N. Note also the alteration in specific gravity. See that the ova are not broken and yet that they come into contact frequently with fresh supply of water. This I have done, and shall give my results later on when I speak of the substances which diffuse out from the ripe and unripe plaice ova.

It was also important to discover whether the ripening of the demersal ovum was simply that of the pelagic cut short before the final stage.

I subjoin a Table giving the water percentage of different ova, determined by the method described previously.

WATER PERCENTAGE OF *Pelagic ova.*

	Unripe.	Ripe.
Plaice,	57·50	91·86 and 91·46
Whiting,	70·71	96·41
Cod,	73·0	91·14
Haddock,	55·00	95·86
Turbot,	69·9	...
Halibut,	63·0	...
Tusk,	77·2	...
John Dory,	73·06	...
Saithe,	...	77·5 (mixture of mature and immature)
Brill,	...	90·00
Flounder,	...	87·20
Ling (fully ripe),	...	85·07 per cent. of water.

Plaice ova were examined in the stage just before maturation and were found to contain 65·38 per cent. water.

WATER PERCENTAGE OF *Demersal Ova* (Immature and Mature).

	Immature.	Mature.
Herring, . .	46·07	70·72 and 69·36
Cottus Scorpius, .	...	74·46
Cat-fish, . .	...	71·30
Lumpsucker, .	...	70·46
Lophius, . .	32·00	68·7
Salmon, . .	7·10 (very immature)	56 7
Trout, . .	...	60·9
Conger eel, . .	9·41 (with some ovarian tissue)	57·7
Sturgeon, . .	36·93	...

Here it is at once noted that the percentage of water in each mature pelagic ovum is much higher than in the demersal ones.

It is of more importance to compare the fully mature ova of each class rather than the immature, as the latter may be obtained at all stages of maturation.

What occurs in all cases is a gradual passage in of water during the process of maturation. In the pelagic the process goes further than in the demersal ovum.

The mature eggs with the highest percentage of water are undoubtedly those of the whiting and haddock. The percentage of water in the fully ripe ova is very constant. I have examined large numbers of plaice, haddock, cod, and whiting ova, and in all cases have found the percentage of water to remain almost at the same figure. One has, of course, to be careful that in removing the ovarian fluid one does not break the ova, as the vitellin fluid then escapes, and during the weighing evaporates off

I have not inserted my analysis of the unripe saithe and flounder, as the results obtained were vitiated by the fact that I could not obtain the eggs unbroken and yet freed from ovarian fluid.

WEIGHT OF THE FRESH OVA OF DIFFERENT SPECIES OF MARINE TELEOSTEANS IN THE IMMATURE AND MATURE CONDITIONS.

As previously mentioned, if one could calculate exactly the volume of the ova from their diameter, it would be an easy matter, knowing their weight, to state their specific gravity; but, unfortunately, the volume cannot be correctly determined from the diameter as the eggs are not absolutely spherical.

If we, however, can determine the weight of the ova, and also find out the amount of water, salts, and organic constituents present at different stages, one can determine whether the increase in volume be due simply to a passage in of water, or of a watery solution containing salts, or of a weak albuminous solution.

In the following Tables I shall give the weight of different immature and mature ova. I shall first take up the pelagic and then the demersal ones:—

WEIGHT OF PELAGIC OVA, IMMATURE AND MATURE (FRESH AND WATER FREE).

(*Stated in Milligrammes.*)

	Fresh Immature.	Fresh Mature.	Total Solids.	
			Dried Immature.	Dried Mature.
Plaice, . .	0·40	3·28	0·17	0·28
Whiting, . .	0·17	0·97	0·03	0·035
Cod, . . .	...	1·58	...	0·14
Haddock, . .	0·20	2·66	0·088	0·11
Saithe, . .	0·40*	...	0·09	...
Brill, . . .	...	2·64	...	0·22
Flounder, . .	...	0·60	...	0·077
Ling, . . .	...	0·67	...	0·093

* In immature plaice ova more mature than those given in the Table, the weights obtained were as follows:—Fresh, 0·78mgm. ; dried, 0·27mgm.

It is at once seen that the increase in volume is mainly due to the water, the total solids present in the immature and mature ova being practically the same. There is a slight increase in the total solids, however.

I have omitted my analysis of the unripe cod, flounder, and ling ova, because I could not get any at a stage when they could easily be detached from ovarian tissue, and yet leave them unbroken.

The saithe roe which I examined contained mainly mature but also some immature ova, and was very difficult to examine, as the eggs were so easily broken.

It is unnecessary to give here any of the further estimations of the weight of pelagic ova, as all show the same marked increase in the water, and the very slightest increase in the solids during maturation.

DEMERSAL.

Now let us turn to the demersal eggs. The ones which I wish especially to refer to are those of the herring and *Lophius*.

(*Stated in Milligrammes.*)

	Fresh Immature.	Fresh Mature.	Total Solids.	
			Dried Immature.	Dried Mature.
Herring, . .	0·51	1·11	0·27	0·34
Lophius, . .	0·25	1·60	0·17	0·50
Catfish, . .	0·55	...	0·13	...
Cottus Scorpius, .	...	4·70	...	1·20
Lumpsucker, .	...	5·90	...	1·70
Trout, . .	...	104	1	40·7
Salmon, . .	...	108	...	43·9

If we take as a typical example of the demersal ovum that of the herring, we note that the increase in weight of the fresh ovum during ripening does not proceed nearly so far as in such a typically pelagic ovum as that of the plaice.

But the total solids in the immature and mature herring ova are very similar in amount, the latter, however, always containing a larger quantity of solids than the former.

That is to say, in the herring ovum, as in the plaice, the most marked change during maturation is an entrance of water from without, and if there is (as we shall see afterwards there does happen to be) a diffusion from without inwards of some solids during maturation, that is partly balanced by the passage from within outwards of solids present in the immature ova.

The immature eggs of *Lophius* are difficult to obtain free from adherent gelatinous matter, hence it was only after repeated determination that I was able to get the one given in the Table. However, the weights of the immature vary as maturation goes on, and the important point after all to settle is not the absolute weight of the ova at different stages of ripening, but the relationships between the water and the solids in ova of different weights at different stages of maturation.

It may seem at first sight that the weights that I am dealing with are so extremely small that it is impossible to avoid fallacies in drawing conclusions from them, but they are the average weights derived from large numbers of ova (200 to 400), so that the error must be a comparatively slight one.

Now, although we have seen that the increase in volume in both pelagic and demersal ova is due to the passage of water from within outwards, we cannot draw from that the conclusion that that is the only, or indeed the principal, change in maturation.

CHANGES IN THE CONSTITUENTS OF THE OVA DURING MATURATION.

As I said at the beginning of this paper, it is necessary to know the amounts of albumin and diffusible salts in the mature and immature ova in order to arrive at any definite conclusion as to the nature of maturation.

One has to be very careful in drawing conclusions from a number of analyses of different varieties of ova, as in many cases it is difficult, if not impossible, to get very immature ova isolated from the surrounding tissue, and yet it is the very immature ova which one wishes to examine, or, at least, not those which are approaching maturation. The pelagic ova which I have examined especially carefully are those of the plaice and whiting. The unripe and ripe eggs of the former are easily isolated and analysed.

I have at the beginning of the paper spoken very shortly of the methods of analyses, but it may be better for me to give the method which I employed for the estimation of the albumin in the different eggs.

In one specimen containing a known number of eggs the water was estimated, while in another a fixed weight of ova was taken (corresponding to a known number of ova). This latter was incinerated with sulphuric acid, cupric sulphate, and potassium sulphate, until all the nitrogen present was fixed as ammonium sulphate. The solution was then made alkaline, and the ammonia so set free distilled over into a fixed quantity of oxalic acid of known strength. From the loss in acidity of the oxalic acid the ammonia was calculated, and, knowing the amount of ammonia, that of nitrogen was easily obtained. If the nitrogen given in the Tables be multiplied by 6·35, the amount of albumin is roughly estimated.

As I shall point out later, it was important, also, to find out whether, during maturation, the phosphorus was increased in amount, and especially if the ratio between the nitrogen and the phosphorus was different in the unripe and ripe ova. I shall only include those analyses in the following Table which have been made more than once :—

PELAGIC OVA N AND P IN MILLIGRAMMES.

	Immature.		Mature.	
	N.	P.	N.	P.
Plaice, ...	·022	·0030	·0270	·0046
Whiting, . . .	·0026	·00012	·0040	—
Haddock, . . .	·0095	·0013	·0146	·0029
Cod, ...	·0099	·0012	·015	·0026
Brill, ...	—	—	·0233	·0033
Flounder, . . .	—	—	·0080	·0010
Ling, ...	—	—	·0082	—
Saithe, . . .	—	—	·004	·00018

RATIO BETWEEN NITROGEN AND PHOSPHORUS IN THE IMMATURE AND MATURE OVA. NITROGEN = 1.

	Immature.		Mature.	
	N.	P.	N.	P.
Plaice, ...	1	·136	1	·170
Whiting, . . .	1	·046	—	—
Haddock, . . .	1	·136	1	·198
Cod, ...	1	·121	1	·173
Brill, ...	—	—	1	·141
Flounder, . . .	—	—	1	·125
Ling, ...	—	—	—	—
Saithe, . . .	—	—	1	·045

During maturation there is an absolute increase in the nitrogen present in the ovum, probably due to a passage inwards of albumin in some form or other. What is especially noteworthy, however, is the marked increase in phosphorus, which is much more distinct than the nitrogen increase. As we shall see afterwards, this is probably due to the passage inwards of an organic phosphorus-holding body, selected by the tunica granulosa cells at the commencement of maturation from the ovarian fluid outside. The nitrogen percentage may be stated as albumin by multiplying by 6·35.

THE AMOUNTS OF SODIUM CHLORIDE IN THE VITELLINE FLUID OF THE UNRIPE AND RIPE PLAICE OVA.

The common salt was selected for analysis, because it is the salt present in largest amount, and is also the most diffusible one. In addition, it is the probable causal agent at play in the clearing up of the yolk in the final stage of maturation :—

I. *Immature Plaice Ova.*—52·531 grammes fresh unripe ova (=18·187 grammes water-free ova) were broken down in a mortar, and extracted with 500cc. distilled water, filtered, and filtrate boiled, and then precipitated with alcohol. In the filtrate the chlorides were estimated by Mohr's method, and were found to amount to ·214 grammes NaCl., or in each ovum ·0031 milligramme NaCl.

II. *Mature Plaice Ova.*—16·007 grammes were treated in the same way as the unripe ova. They were found to contain ·0945 gramme NaCl., or in each ovum ·020 milligramme NaCl. That is to say, during maturation there is a marked increase in the chlorides accompanying the increase in water.

SUBSTANCES WHICH DIFFUSE OUT INTO DISTILLED WATER FROM UNRIPE AND RIPE PLAICE OVA.

In order to find out the form in which the albumins, salts, etc., are bound in the ova, I took weighed quantities of ripe and unripe eggs, and allowed them to circulate through distilled water for fixed periods. All the chloride present as inorganic salt in the vitelline fluid passed out into the water, and, in addition, a small extra amount of chlorides passed out beyond that which had been present as sodium chloride in the yolk. This extra amount of chloride had evidently been bound with albumin, and the combination was broken up during the process of diffusion. This points to the active part which the chlorides must play in the clearing up of the yolk. This holds for both the ripe and unripe eggs.

Of the total phosphorus in the unripe ova before diffusion, 10·47 per cent. diffuses out, and all of this practically is in organic combination, and is precipitable with alcohol. That is to say, the organic phosphorus-holding constituent of the yolk of the plaice ovum is an easily diffusible body. This is a point of great importance, for, as we shall see, there is a similar body in the ovarian fluid.

Of the total phosphorus present in the ripe plaice ovum, 52·6 per cent. diffuses out during the same time, and under the same conditions, as in the case of the unripe ova. Practically all this phosphorus also is in organic form (vitellin). The organic form of the body is maintained after diffusion into the distilled water.

Of the total albumin in the unripe ovum, 1·414 per cent. diffuses out; and of the total solids diffused, 8·78 per cent. is in the form of albumin. In the ripe ovum, on the other hand, 3·294 per cent. of the total albumin passes out, but of the total solids diffused, only 6·145 per cent. is in the form of albumin.

That is to say, everything points to the fact that in the ripe ovum the substances present are in a condition more suitable for diffusion than in the unripe. Some of the important points with regard to the phosphorus I have already emphasised; but there is still one of great importance that I have just referred to, and that is the amount of inorganically and organically bound phosphorus in the unripe and ripe ova.

Is there any transformation of inorganically-bound phosphorus into organically-bound during maturation?

In the unripe haddock ovum 24·47 per cent. is in inorganic form, the rest organically-bound; while in the ripe haddock ovum 21·22 per cent. is in inorganic form, the rest in organic combination. That is to say, in the unripe ovum there is more inorganic phosphorus than in the ripe ovum, but the difference is, comparatively speaking, a small one. What is of far greater importance is the fact that much the larger proportion is in organic form in both cases, and hence more suitable for assimilation.

There are two constituents of the ovum which I have not yet referred to, or only incidentally, and those are the fat and lecithin. Both are present in all the Teleostean ova that I have examined, but the amounts differ.

As an example of the class which contains no oil-globule in the yolk, the plaice may be taken, while the ling may be taken as characteristic of the class which does contain such an oil-globule.

The amounts of fat and lecithin in Teleostean ova, and their significance, I shall leave over for discussion in another paper, as the results which I have arrived at are not conclusive.

Shortly summed up, the changes that occur during the maturation of pelagic and demersal ova are:—

(1.) Increase in volume.
(2.) Clearing up of yolk, with disappearance of germinal vesicle.
(3.) Diminution in specific gravity.
(4.) Increase in percentage of water.
(5.) ,, chlorides.
(6.) ,, total solids—albumin, etc.
(7.) ,, phosphorus—mainly organically bound.
(8.) Changes (within the ovum), probably of the nature of condensations of most of the organic substances secreted into the vitellus, by means of which complex organic bodies are formed. Probably there is also a transformation of some of the inorganic into organically-bound phosphorus.
(9.) A transformation of less diffusible into more diffusible bodies.

NATURE AND COMPOSITION OF SOME OF THE OVARIAN FLUIDS.

It is of importance in the investigation of the nature of the maturation process to know the composition of the ovarian fluid, hence I have made some analyses which may help to elucidate some points. The fluid was obtained from the roe by allowing the fluid to drain through muslin. The specific gravity was estimated in the first place, and was always found to be distinctly lower than that of the ova. The reaction was almost always neutral. In *Lophius*, however, and in the roes of some demersal varieties, it was found to be acid.

There are three constituents of the fluid which require to be specially considered, viz.:—

(1.) The albumins.
(2.) The chlorides.
(3.) An organic phosphorus-holding proteid similar to that present in the vitellus.

Ovarian Fluids.	Sp. Gr.	Reaction.	Chlorides.	Albumin.
Turbot (Unripe), .	1·020	Slightly acid.	—	—
Haddock (Ripe), .	1·015	Neutral.	·846 gms. %	—
Plaice (Ripe), .	1·0016	„	·766 „	·838 gms.
Cod (Ripe), . .	1·017	„	·492 „	1·312 „
Whiting, . .	1·015	„	·630 „	—
Flounder, . .	1·020	„	·552 „	—
Ling, . . .	1·014	„	—	—

In all cases, a body is precipitated by adding acetic acid carefully to the fluid. This precipitated body contains phosphorus, but does not furnish nuclein bases. It gives the ordinary proteid reactions.

In many respects it is similar to the vitellins present in the yolk, and is a probable forerunner of them.

The interstitial mucoid-like tissue in which the eggs of *Lophius* are embedded requires separate treatment. The specific gravity of this substance, with the eggs embedded in it, was 1·005, while the ripe ova alone had a specific gravity of 1·030 to 1·035. Both the mucoid-like tissue and the vitelline fluid of the ova react acid, the acidity of the two being almost identical in amount. I was never able to obtain from the organic phosphorus-holding body present in the ovarian fluids a CuO reducing substance, nor from the gelatinous-like interstitial substance in the roe of *Lophius.*

In the ripe *Lophius* roe 20·22 per cent. of the total weight is due to the ova, and the rest to the mucoid-like tissue.

Chlorides are present in this substance, but, so far as I could make out, no body similar to that precipitated by acetic acid in the other ovarian fluids. Unlike most mucoid tissues, no cupric oxide reducing body is obtained by boiling this substance in dilute acids for long periods. The water percentage is higher than that of the ova, viz., 84·74 per cent., while the ova only contained 68·70 per cent.

I should like, in conclusion, to say a few words on the rôle of the phosphorus in maturation.

THE RÔLE OF THE PHOSPHORUS IN MATURATION OF OVA.

The most important organic constituents present in the ovum are those which contain phosphorus. The yolk contains vitellins or forerunners of the vitellins, and those are substances which contain in their molecule an organic phosphorus-holding radicle—paranuclein. These are, without doubt, concerned in the formation of the so-called chromatin of the histologist. I have examined and analysed these vitellins in a number of ova, *e.g.*, in the ova of the salmon, skate, shark, plaice, etc. I have referred to the chemical nature of these vitellins earlier in the paper.

If, then, these bodies be closely allied to the true nucleins of the vitally active cells, it is exceedingly important to find out how they are formed. Are they synthetically formed in the ovum, or are they selected ready formed from the ovarian fluid by the granular cells?

In one of Miescher's letters, published in his *Gesammelte Abhandlungen*, there is the statement that in the ripe ovum the phosphorus is practically all organically formed. I have estimated the organic and inorganic phosphorus in the unripe and ripe haddock ova, and find, as I have stated before, that in the former 24·47 per cent. is inorganically formed, the rest being in organic combination; while in the latter 21·22 per cent of the total phosphorus is inorganically formed.

That is to say, undoubtedly the mass of phosphorus present is in organic form, but by no means all, either in the unripe or ripe ova.

The phosphorus which is organically bound is in two forms—viz., lecithin and vitellin, and both are more or less firmly attached to one another.

These two bodies are not simply used up as food stuffs, but are forerunners of specific constituents of the embryo. It is very doubtful if there is always in the nucleus of the resting ovum true nuclein of the kind that is met with in the nuclei of pus cells for example. At least I have tried to obtain the decomposition products of the true nucleins from large quantities of ova, but have only obtained small quantities of nuclein bases.

One point of very great importance with regard to the phosphorus-holding constituents of the ovum is to find out how they are bound, and where they come from. I have tried to find out the origin of the phosphorus of the ovum by first examining the ovarian fluid and then the ova from the same ovary, in order to find out if the bodies in the two were similar or quite distinct in character; and, in the second place, by employing the method of diffusion, I have tried to find out which of the phosphorus-holding parts pass out, and how they pass out.

The unripe and ripe ova of the haddock were examined in order to find out how the phosphorus was bound, and, as I have previously stated, in the former more phosphorus exists in the inorganic form than in the latter, but in both the organically bound phosphorus is present in largest amount. Ripe and unripe plaice ova were allowed to remain in contact with distilled water for prolonged periods, with the result that in both cases phosphorus was found to pass outwards mainly in organic form. Ovarian fluids of the plaice and haddock ripe roes, in addition to those of numerous other fishes, were examined and were found in all cases to contain the phosphorus mainly in organic combination in the form of a body precipitable by acetic acid in the cold, a substance probably of the nature of a nucleo-albumin. In the different specimens I have examined this body contained more phosphorus than the vitellins of the yolk. It is just possible that it is one of the bodies which, by synthesis in the outer parts of the ovum, is formed into vitellin or a forerunner of vitellin (vitellogen).

As to whether any inorganically-bound phosphorus is synthetically transformed during maturation into an organically-combined phosphorus-holding body or not, I am still unable to say. It is important to remember that every living cell is so constituted that it can take up from the fluids surrounding it just those constituents which are necessary for its growth, and the medium in which the cells are situated contains those constituents in the proportions most suitable for absorption.

During maturation the ovum is a miniature chemical laboratory, absorbing oxygen, organic and inorganic substances, and transforming these into bodies suitable either for the nourishment or formation of the embryo. During the growth and maturation of the ovum, a large part of the chromatin of the germinal vesicle may be lost by passing out into the cytoplasm, forming there accessory nuclei, or undergoing regeneration still further in the protoplasm. This is especially well seen in the eggs of amphibia, echinoderms, and some worms.

It seems to me doubtful whether this is due to the entrance of such a salt as sodium chloride from without, or to the lack of oxygen in the interior of the egg, resulting in the liquidation and passage outwards of substances situated there.

It seems most likely that the outer part of the ovum, where oxygen freely enters, is the seat of the syntheses or condensations.

In conclusion, I have to thank the Fishery Board of Scotland for their generosity in providing me with so much material, and very especially am I indebted to Dr. T. Wemyss Fulton, their Scientific Superintendent, for his most valuable advice and kindly help in difficulties.

V.—ON THE DISTRIBUTION OF PELAGIC INVERTEBRATE FAUNA OF THE FIRTH OF FORTH AND ITS VICINITY during the Seven Years from 1889 to 1895, both inclusive. By THOMAS SCOTT, F.L.S., Mem. Soc. Zool. de France. (Plates IV., V., VI., VII.)

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INTRODUCTORY.

The scientific investigations that have until recently been carried on in the Firth of Forth, and also outside the limits of the estuary, included among other things the examination of the various groups of pelagic invertebrates that form so important a part of the food of fishes. The examination was carried on chiefly in connection with the trawling operations of the *Garland*, the steam cruiser set apart specially for scientific work. The trawling experiments of the *Garland* were made over certain fixed portions of the estuary and neighbourhood which were denominated "stations." The method adopted for the examination of the pelagic invertebrates was somewhat as follows:—During the time that each station was being trawled two tow-nets were kept constantly at work. One of these was towed at about half a fathom below the surface of the water, and was distinguished as the surface tow-net; the other was fastened to the end of the beam of the trawl in such a way as just to clear the bottom, and was distinguished as the bottom tow-net. Sometimes other nets were used at intermediate depths, but not with the same regularity as the first two. The gatherings collected with these mid-water nets are therefore not specially referred to in this paper. The tow-nets at first in use were comparatively of small size, but subsequently a larger kind, somewhat similar to those that had been used on board the *Challenger*, were adopted, and are still used in connection with the Board's scientific work.

At first nine experimental stations were selected for the carrying out of special scientific work, but this number was afterwards increased to ten. It has not, however, been considered necessary for the purposes of this paper to take note of the published statistics for all these stations, and therefore six of them have been fixed upon as representative of the others—namely, Stations I., III., IV., V., VIII., and IX. Stations I. and III. extend from the east side of Inchkeith eastward, and are comparatively near to each other. Station IV. is an inshore station, and extends for a considerable distance round the "South Bay." Station V. extends from May Island westward along the centre of the Firth till nearly abreast of Elie. Stations VIII. and IX. are beyond May Island, and outside the limits of the estuary.

The results obtained by the use of the tow-nets were at first recorded in a somewhat general form, but as the work proceeded the differentiation of the various organisms became less difficult, and made it possible for a more detailed description of the results being placed on record. It will be obvious, therefore, that in the study of the distribution of the pelagic invertebrates the earlier records will not be so useful as those of subsequent date. Moreover, the investigations were not carried on during the first year or two so continuously as they were afterwards, and for these reasons I propose to limit the consideration of the pelagic invertebrates to those collected (by means of the surface and bottom tow-nets already described) during the seven years from 1889 to 1895 inclusive, and recorded in the several Annual Reports for these years.

But though the examination of the pelagic invertebrates within the area under consideration was carried on more or less continuously and regularly during the years referred to, there are times when, for various reasons, no tow-net gatherings were collected, and for which there are no records, so that the records for some years are less complete than for others. In 1889, for example, there are no records of tow-net gatherings for any of the stations in March, April, and December; in 1890, in January and June; in 1892, in August; in 1894, in March, May, July, September, and October; and in 1895, in March, June, and November. Moreover, there may be records for a particular month for some of these stations and not for others. Thus in 1889 though there are records for October for Station I. there are none for any of the other stations; but while that is so there are still a large number of statistics available for at least a partial study of the distribution of the pelagic invertebrates of the Firth of Forth.

The time available for the preparation of this paper did not permit of the detailed consideration of every species or kind of invertebrate recorded in the lists of tow-net gatherings, so that only those that are of numerical importance, or that are otherwise of importance from a fisheries' point of view, are so dealt with, while an endeavour is also made to invite attention to any interesting point observed in connection with the distribution of the other species. Tables illustrating in time and space the distribution of these pelagic forms are introduced wherever they are considered necessary.

Moreover, four charts are added at the end of the paper for the purpose of supplementing and extending the information given in the Tables concerning the distribution of a few of the more, numerically or otherwise, important species or groups of invertebrates comprised in the tow-net lists. These charts not only show when and where the species was abundant, or scarce, or absent, but they also allow of a comparison being made between the surface and bottom distribution of the species. The importance of this will be evident when it is remembered that though a species may be rare at the surface it may at the same time be common or even abundant at the bottom, as well as *vice versa*.

It may further be stated that in proceeding to consider the distribution of the invertebrates mentioned in the various lists of tow-net gatherings collected at the six selected stations during the seven years, those that are higher in the scale of classification are referred to first, and afterwards those that are lower.

It may also be as well to state that there has been a considerable advance in the knowledge of marine zoology since the *Garland* commenced work in the Firth of Forth twelve years ago,* and one of the results of this advance has been the introduction of many changes in the nomenclature of marine organisms. Owing to these changes several of the names mentioned in the *Garland's* tow-net lists are replaced by those that are now considered to be the rightful designations of the species to which they refer; and one advantage of this alteration will be that the results of the tow-net work of the *Garland* will be brought more into line with present-day knowledge.

INVERTEBRATES CAPTURED BY THE TOW-NETS.

The invertebrates captured by means of the surface and bottom tow-nets during the seven years from 1889 to 1895, at the representative stations already referred to, comprised a large number of forms of different kinds, but many of these were only of rare occurrence. The greater proportion by far of the contents of all the tow-net gatherings consisted of only a few species, which may be summed up as follows:—Schizopoda (*Thysanoessa* chiefly, *Erythrops*); Amphipoda (*Hyperia*, *Hyperoche*, and *Parathemisto*); Copepoda (*Calanus*, *Temora*, *Acartia*); *Sagitta*; Cœlenterata (*Pleurobrachia*, *Beroë*, and others); and young Crustacea (Decapoda, Schizopoda, and Cirrepedia). Before proceeding to discuss the distribution of these six groups, as brought out by an examination of the tow-net records, I propose to refer briefly to several of the more uncommon forms which have been captured from time to time at the selected stations and during the years already specified.

(1.) The Mollusca.

There are very few records of Mollusca which have been captured by the tow-nets, and only two really pelagic forms have occurred. The Mollusca recorded comprise two small *Eolis*, the species of which was not determined. One was obtained in the bottom tow-net at Station V. in 1891, and the other at Station I. in May 1895; also *Doris* (?) *repanda*, which was obtained in the bottom net in November 1890 at Station III., and *Doto coronata*, obtained in December 1890 at Station IV., also in the bottom net. A few species of *Cuspidaria cuspidata* are recorded under Station IX., having been brought up in the bottom tow-net at that station in April 1893, but the presence of this species was owing, no doubt, to the net having accidentally dipped into the mud at the bottom. The two pelagic species are the Pteropods *Limacina retroversa* and *Clione borealis*. The first is recorded on two different occasions in 1890, having been obtained in April in the bottom tow-net at Station V., and in May in a surface-net gathering at Station I. It was also obtained in the bottom tow-net at Station III. in July 1891, and in the bottom tow-net at Station IX. in December 1892. The other (*Clione borealis*) was captured in the surface tow-net at Station III. in January 1889, in the bottom tow-net at Station V. in November 1893, and in the surface net at Station VIII. in December of the same year. *Limacina retroversa* is a very generally distributed species, but seems to be more common on the West than it is on the East Coast. On the West Coast it sometimes occurs in immense shoals, and at times forms a considerable part of the food of the herring. I have found the stomachs of herrings sent to me from the West Coast for examination filled with little else than these Pteropods, numbers of which appear to have been swallowed wholesale, as some of the shells were practically uninjured. *Clione*, which has no shell, is a northern species, and is a rare visitant to the Firth of Forth. All the three recorded instances of its occurrence happened during the winter months. This was probably owing to the temperature of the water at that season being more favourable to its wandering habits, or the specimens may have been carried south by currents coming down from the North Atlantic. Another point connected with the capture of the *Clione* is, that on the two occasions in which it occurred in the surface tow-net the surface of the sea was smooth or but slightly disturbed, but on the occasion when it was found in the bottom tow-net the weather was stormy and the sea rough.

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* It is pleasing to know that the little steamer belonging to the Fishery Board for Scotland has had some share in promoting this advance, though perhaps the time has not yet come for the full appreciation of the *Garland's* work.

(2.) THE CRUSTACEA.

(*a*) DECAPODA.

The Decapoda captured by the tow-nets comprised the following species :—

Macropodia rostrata (Linn.),
Crangon allmanni, Kinahan,
Egeon fasciatus, Risso,
Cheraphilus nanus (Kroyer),
Hippolyte varians, Leach,
Hippolyte fascigera, Gosse,
Spirontocaris pusiola (Kroyer),
Pandalus montagui, Leach,
Pandalus brevirostris, Rathke,

all of which, with the exception of the first, belong to the Carida. They were all captured in the bottom net at various times and at one or more of all the selected stations.

Macropodia is only recorded twice during the seven years—once in October 1890, from Station IV., and again from the same station in August 1891.

Crangon allmanni occurred more frequently than any of the Decapods mentioned, and there are records of its capture with the bottom tow-nets in all but one of the seven years, 1889 being the only year in which no distinct record of the species occurs. In 1890 it is recorded twice, once in February and once in November, both records being for Station V. It is also recorded twice in 1891, once in March for Station V. and in September for Station III. There are seven records for 1892—viz., in January, March, and November for Station I., in February for Station III., in February for Station IV., and in January and February for Station V. There is only one record for 1893—viz., one for Station V. in

November. In 1894 there are three records, one in February for Station IX., and in August one each for Stations I. and III. In 1895 there are six records, one in February for Stations III., IV., V., and VIII., and one in September for Stations VIII. and IX., or twenty-one records in all for this species of Crangon. Nine (or nearly 43 per cent.) of the records are for February alone, and if those for January and November are included they amount to two-thirds of the whole number, the other records being divided almost equally among the three months March, August, and September.

Egeon (*Crangon*) *fasciatus* is only recorded once during the seven years—viz., for Station III. in September 1891.

Cheraphilus (*Crangon*) *nanus.* There are several records of this species during the prescribed period. Three of these occur in 1891, one in March for Station I. and one in the same month for Station V. The third record occurs in September for Station III. In 1892 there are four records, two for Station I. in January and March, one for Station III. in February, and one for Station V. in January. There is one in February 1894 for Station III., and one in the same month of 1895 for Station VIII., or nine records in all for *Cheraphilus nanus*, and, with the exception of the one in September for Station III., they all occur in the colder months.

Hippolyte varians. There is but one record of this species—viz., in December 1890 for Station V.

Hippolyte fascigera. This species is recorded for Station VIII. in January 1894, and in February 1895 for the same station.

Spirontocaris (*Hippolyte*) *pusiola* is recorded only once—viz., in February 1895 for Station IV.

Pandalus montagui (= *P. annulicornis* of Bell's *Stalk-eyed Crustacea*). The number of records for this species is seven, one for Station VIII. in February 1890; one in September 1891 for Station III. In 1892 there is one record in January for Station I. and also for Station V., and one in February for Station III. In 1893 there is one for Station V. in November, and one in February 1895 for Station VIII.

Pandalus brevirostris. For this species there are two records, and both are for 1891; one is for Station V. in March, and the other for Station III. in September.

It thus appears that nine species of named Decapod Crustacea have been captured during the six years from 1890 to 1895 (one or two Decapods are recorded for 1889, but only by their generic names, and are therefore not included here). These nine species were all captured with the bottom tow-net—not a single instance is recorded of the occurrence of any of them in the surface nets. The records for the whole nine species for the six years number 46. They are tabulated under eight out of the twelve months, and are characterised by the great majority of them being included in the statistics for the five months that are usually the colder months of the year. The subjoined formulæ will show some of these details more clearly :—

(1) The months in which the capture of Decapoda are recorded	Jan.	Feb.	Mar.	Aug.	Sept.	Oct.	Nov.	Dec.
Number of records for each of the months for the seven years	7	17	6	3	7	1	4	1

(2) The Stations where the Decapoda were captured	I.	III.	IV.	V.	VIII.	IX.
Number of records for each station	7	11	5	13	7	3

The number of records for February alone is 17, or 27 per cent. of the whole; and the number for the five colder months, January, February, March, November, and December, is 35, or fully 76 per cent. The reason that these Decapods are found usually in the bottom tow-nets, and not in those worked at the surface, is that they are veritable bottom feeders; and were it not for their peculiar habit of springing upward as well as backward when disturbed, their capture would be much less frequent. When any suspicious object is approaching these Crustaceans (I refer to the Carida or "shrimp" group) they face round towards it and intently watch its movements, and at the same time swim gently backwards, or they may at once bury themselves in the sand or mud. If the danger, however, should approach them suddenly, they spring quickly backwards and also obliquely upwards, and it is then that they come within the sweep of the bottom tow-net. But though the occurrence of these organisms in the bottom tow-net may be thus more or less satisfactorily explained, the reason for their being captured chiefly during the colder months seems to be less easy of explanation. It may be observed, however, that only five of the records are for the inshore station, and that about half of the total number are for Stations III. and V., the two stations in the middle of the estuary, the one extending east from Inchkeith the other west from May Island.

(*b*) SCHIZOPODA.

The Schizopoda are well represented as regards the number of species, and a few of them, especially those of the Euphausiidæ, appear to have been at times pretty numerous at the station under consideration. The Schizopods referred to in the records and distinguished by their names are the following:—*

EUPHAUSIIDÆ.

Boreophausia raschii (M. Sars).
Thysanoessa neglecta (Kroyer).

MYSIDÆ.

Siriella jaltensis, Czern. (= Siriella crassipes, G. O. Sars).
,, *armata* (M. Edw.).
Gastrosaccus spinifer (Goës).
Heteromysis formosa, S. I. Smith.
Erythrops goësii, G. O. Sars.
Mysidopsis didelphys (Norman).
,, *gibbosa*, G. O. Sars.
,, *angusta*, G. O. Sars.
Leptomysis gracilis, G. O. Sars.
,, *lingoura*, G. O. Sars.
Hemimysis lamornæ (Couch).
Macropsis slabberi (Van Ben.).
Praunus flexuosus (Müller). (= *Mysis chamæleon*, Varg.).
,, *inermis* (Rathke).
Schistomysis spiritus, Norman.
,, *ornata* (G. O. Sars).
Neomysis vulgaris (J. V. Thompson).

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* The names and their arrangement are in accordance with Rev. A. M. Norman's revision of the British Schizopoda, published in the 'Annals and Magazine of Natural History' for June, August, and September 1892.

Owing to the difficulty of distinguishing the species of Schizopoda offhand, their occurrence is frequently recorded in the lists of tow-net fauna simply under the family names, "Ephausiidæ" or "Mysidæ," or the generic names "Boreophausia sp.," "Mysis sp.," as the specimens observed happened to belong to either group; and before taking up the consideration of the detailed species, it is proposed to consider briefly the distribution of the Schizopoda under these names, as follows:—

The Euphausiidæ.—The records of the Schizopoda under the name of Euphausiidæ or *Boreophausia* sp. amount to one hundred and twelve for the seven years, and taking the one year with the other, they are distributed over all the twelve months; but the largest number occur in the first four and the last three months, as indicated by the Table annexed, which shows the number of the records of the Euphausiidæ that are referred to simply under their family or generic names for each station, and for each month of the year for all the seven years.

Table I., showing the Distribution of the Euphausiidæ, as indicated by the Records for the Years, Months, and Stations:—

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Totals for the Years.	Years.	I.	III.	IV.	V.	VIII.	IX.	
1889, .	1	–	–	–	–	1	1	1	–	1	–	–	5	1889, .	2	–	–	2	–	1	5
1890, .	–	3	6	3	–	–	3	–	–	3	2	1	21	1890, .	2	5	2	6	3	3	21
1891, .	4	3	2	1	7	4	–	–	–	–	–	1	22	1891, .	4	7	5	2	4	–	22
1892, .	3	4	5	2	4	–	1	–	1	–	–	–	20	1892, .	2	5	1	3	3	6	20
1893, .	7	4	–	1	–	–	–	–	1	4	4	6	27	1893, .	5	7	3	6	3	3	27
1894, .	2	6	–	1	–	–	–	–	–	–	–	1	10	1894, .	3	1	1	2	2	1	10
1895, .	–	2	–	–	–	–	–	–	–	1	–	5	8	1895, .	1	3	1	–	1	2	8
Totals for the Months,	17	22	13	8	11	5	5	1	2	9	6	14	113	Totals for the Stations,	19	28	13	21	16	16	113

Of these records thirty-one are for the Euphausiidæ observed in the surface tow-nets, while the other eighty-one are bottom tow-net records. In few of the surface gatherings were Euphausiidæ frequent or common, but in a number of the gatherings collected with the bottom tow-nets they were fairly numerous. The results brought out by these Tables regarding their distribution are referred to further on in connection with the detailed account of the different species.

Meanwhile I proceed to notice the records of the second group of the Schizopoda as they appear under the general name of *Mysis* sp. or Mysidæ. I find that there are only thirty-three separate notices of Mysidæ, and three of these are entered under the name *Leptomysis* sp. The reason for this is that most of the Mysidæ were usually not so plentiful, and were identified at the time or shortly after they were collected. The records of Mysidæ, though few in number, show a distribution very similar to the Euphausiidæ—that is, they occur chiefly among the statistics for the colder months. There are no records of Mysidæ for the three summer months, while those for February, November, and December are together equal to 71 per cent. of the whole number. I shall now leave these more general groups for the present, and proceed to consider the distribution of those forms recorded under distinctive specific names.

(*i.*) *The Euphausiidæ.*

Boreophausia raschii. The records of this species are comparatively few, and are all included in the statistics for 1889 and 1890. In 1889 there are eleven records of this species, one each for Stations I., III., and IV. in January, one each for Stations I. and V. in February, and one each for all the six stations in November. There are three records for 1890, one each for Stations I. and VIII. in February, and one for Station IV. in March.

Thysanoessa neglecta. This is the Schizopod that is usually referred to in the records as "*Thysanoessa* sp." It was observed in 1891 at Station III. in October, and again at the same station in November; it was also observed in November at Stations V. and VIII. In 1892 the records for *Thysanoessa* are as follows:—For Station I. in September, and again in November and December; for Station III. in December, and in the same month at Station IV.; at Station V. in October, and again in November and December; once at Station VIII. in October, and on two different occasions in December (on one of these occasions the species was observed in both the surface and bottom tow-nets); at Station IX. it was also taken twice in December, one on the 2nd and again on the 22nd. There are only two records for *Thysanoessa* in 1893—viz., in January for Station III. and in September for Station I. The only records in 1894 are two in December, when the species was taken in both the surface and bottom tow-nets at Station III. In 1895 there is no distinct record for *Thysanoessa*, and it probably was not observed during that year.

(*ii.*) *The Mysidæ.*

Siriella jaltensis. (This is equal to *S. crassipes*, G. O. Sars, of earlier papers.) There is but one record for this among the faunal lists for the seven years; it was obtained at Station V. in March 1893.

Siriella armata is another species that is seldom met with in the Firth of Forth, and only one record of it is published in the lists of tow-net fauna of the selected stations; it occurred at Station III. in March 1892.

Gastrosaccus spinifer. There are records of this species from one or other of the selected stations for all the seven years except 1891. The first record is for Station VIII. in November 1889. In 1890 the species is recorded for Station VIII. in December, and for Station IX. in August. In 1892 for Station I. in January, and Station V. in March. There is only one record in 1893—viz., for Station I. in January, and one in 1894 for Station III. in February. In 1895 there are two records, one for Station III. in February, and one for Station VIII. in December.

Heteromysis formosa is one of the rare species recorded for the Firth of Forth, and has only been observed twice during seven years—viz., at Station I. in August 1894, and at Station IV. in February 1895.

Erythrops goësii. This Mysid, though not known to occur in Britain previous to the institution of the Board's scientific investigations, is the most common of the Mysidæ in the seaward part of the Forth estuary, and there are several records of it for all the selected stations. In 1889 it is recorded in January for Station III., in February for Station I., and in November for Station VIII. In 1890 there are records of it for Station I. in October and November; for Station V. in February, September, November, and December; for Stations VIII. and IX. in February, and again in April; for Station IX. in August; and for Station VIII. in December. In 1891 the records include one for Station I. in March, and for Station III. in September and November, and for Station V. in March and Station VIII. in June. In 1892 *Erythrops* is recorded for Station I. in January, March, and November, and for Station III. in February. It is also recorded for Station V. in January, February, March, May, September, and December; for Station VIII. once in March and September, and twice in December; and for Station IX. in May, July, and December. The records for 1893 are comparatively few in number, and include one for Station III. in December, one for Station V. in March and November, for Station VIII. in December, and Station IX. in February and October. In 1894 there are only three records, one for Station III. in February, and two for Station V., one each in February and August. There are several records for 1895, and they are distributed as follows :—One for Station I. in April, one for Station III. in February, and again in October, one for Station V. in February, one for Station VIII. in February, May, and December, one for Station IX. in April, and one each for Stations VIII. and IX. in September. The annexed Tables show (1) the number of records for the months and years and (2) the number for the years and stations.

TABLE II., showing the Distribution of *Erythrops goësii*, as indicated by the Records for the Years, Months, and Stations :—

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total for each Year.	Years.	I.	III.	IV.	V.	VIII.	IX.	Total for each Year.
1889, .	1	1	–	–	–	–	–	–	–	–	1	–	3	1889, .	1	1	–	–	1	–	3
1890, .	–	3	–	2	–	–	–	1	1	1	2	2	12	1890, .	2	–	–	4	3	3	12
1891, .	–	–	2	–	–	1	–	–	1	–	1	–	5	1891, .	1	2	–	1	1	–	5
1892, .	2	2	3	–	2	–	1	–	2	–	1	4	17	1892, .	3	1	–	6	4	3	17
1893, .	–	1	1	–	–	–	–	–	–	1	1	2	6	1893, .	–	1	–	2	1	2	6
1894, -	–	2	–	–	–	–	–	1	–	–	–	–	3	1894, .	–	1	–	2	–	–	3
1895, .	–	3	–	2	1	–	–	–	2	1	–	1	10	1895, .	1	2	–	1	4	2	10
Total for each Month,	3	12	6	4	3	1	1	2	6	3	6	9	56	Totals for the Six Stations,	8	8	–	16	14	10	56

Mysidopsis didelphys. There are only three records for this species, one for Station VIII. in December 1890, and two in March 1891—one for Station I. and another for Station V.

Mysidopsis gibbosa is recorded for Station III. in January 1889 ; for Station IX. in August 1890; for Station I. in March 1891, and for Station III. in January and September of the same year. In 1892 there is a record for Station I. in January and Station IV. in March, while the only record in 1894 is one for Station III. in February.

Mysidopsis angusta. The only records of this species are all for 1890 except one, and comprise one for Stations I. and III. in October, and one for Station V. in October, November, and December in 1890, and one for Station III. in 1891.

Leptomysis lingoura is recorded once during the seven years—viz., for Station III. in March 1892.

Hemimysis lamornæ. This Schizopod is recorded three times in 1892—viz., twice for Station I., once in January and once in March, and for Station IX. in December. The species is recorded again in 1893 for Station V. in January, and in 1895 for Station III. in February and Station VIII. in December.

Macropsis slabberi, remarkable among British Schizopods for the length of the eye-stalks, is of frequent occurrence over a considerable portion of the Forth estuary, and specially in the upper reaches. While several of the species mentioned here may be regarded as only visitors, this appears to be a resident, at least in that part of the Firth which extends westward from Queensferry. In this part of the Forth, which may be considered the headquarters of the species on the East Coast of Scotland, it may sometimes be found in large numbers, and its presence seaward may be due to the overcrowding in these waters causing a greater amount of migration to take place, though it is also possible that the species may be resident in the seaward as well as the landward part of the Firth. The records of the species that have to be noted in connection with the present inquiry are the following :—The first reference to *Macropsis* occurs in February 1890 for Station IV., and again for the same station in March. There is no further record of it till October, when it is again recorded for that station and also for Stations I. and III. It is again recorded for the same three stations in November, and the November record for Station IV. is for both surface and bottom tow-nets, while the others are for the bottom tow-nets only. In 1891 there are records of this species for Stations III. and IV. in January, for Stations I. and III. in October, and in the same months for Station IV. The October record for Station IV. is for the surface tow-net. In July of the same year *Macropsis* is recorded as frequent in a surface tow-net gathering at Station VIII. in July, which seems to indicate a considerable migration of the species seaward, either from the upper parts of the estuary or elsewhere. In 1892 it is recorded for Station I. in January and for Station IV. in March. In 1893 the first record is for Station IV. in January, while the next records are for Stations I. and III., the first being for November, the other for October. There are no records of *Macropsis* for 1894. The records for 1895 include one for Station III. in February and another for the same station in October. There is one for Station IV. in February, and two for the same station in October, one for the surface tow-net and one for the bottom tow-net ; and another for the same station in December.

Praunus flexuosus. This species, which is more familiar by its older name of *Mysis chamæleon* or *Mysis flexuosa*, is, though a common one, infrequent among the tow-net invertebrates from the selected stations. In 1892 it is recorded for Station IV. in January and March; in 1893 for Station III. in December ; in 1894 for Station III. in February ; and in 1895 for Station IV. in January, and for the same station in February. *Praunus flexuosus* was observed only among bottom tow-net gatherings.

Praunus (*Mysis*) *inermis.* The only records for this species occur in 1895, in February, and comprise one each for Stations V., VIII., and X., all being bottom tow-net gatherings.

Schistomysis spiritus. This species is recorded for Station IX. in November 1889; for Station I. in October 1890; and in the same year for Station V. in November and December. In 1891 it is recorded for Station I. in March, for Station IV. in January, and for Station V. in November. There are no records for 1892. In 1893 there is a record for Station III. in January, and one in February 1894 for the same station. There is no record of *S. spiritus* for 1895.

Schistomysis ornata. This, which is one of the most richly coloured of the British Mysidæ, is also at times moderately frequent in the Firth of Forth, and there are several records of its occurrence at most of the selected stations. The first record is for Station I. in August 1889. In 1890 there are records of it for Station I. in October, for Station V. in February, November, and December, for Station VIII. in February, April, and December, and for Station IX. in February and October. In 1891 it is recorded for Station I. in March, and for Station III. in September. It is also recorded for Station IV. in March and November. In 1892 it is recorded in January and March for the two Stations I. and V. There are no records for 1893. In 1894 it is recorded for Station III. in February. In February 1895 it is again recorded for Station III., and for Station IV. in January. All the records are only for bottom tow-nets.

Neomysis vulgaris. The only record for this species is one for Station IV. in December 1892, from the surface tow-net.

Table III. shows the distribution of the whole of the species of Mysidæ referred to in the preceding notes for the years and months and also for the stations; while Table IV. shows, in the same way, the distribution of the whole of the Schizopoda.

Table III., showing the Distribution of all the species of Mysidæ for the Years, Months, and Stations.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Totals for the Years.	Years.	I.	III.	IV.	V.	VIII.	IX.	Totals for the Years.
1889, .	2	1	–	–	–	–	–	1	–	–	3	–	7	1889, .	2	2	–	–	2	1	7
1890, .	–	7	1	3	–	–	–	3	1	10	9	8	42	1890, .	7	3	5	12	8	7	42
1891, .	4	–	9	–	–	1	1	–	3	4	3	–	25	1891, .	7	8	5	3	2	–	25
1892, .	8	3	12	–	2	–	1	–	2	–	1	6	35	1892, .	10	3	5	9	4	4	35
1893, .	4	1	2	–	–	–	–	–	–	2	2	3	14	1893, .	2	4	2	3	1	2	14
1894, .	–	7	–	–	–	–	–	2	–	–	–	–	9	1894, .	1	6	–	2	–	–	9
1895, .	2	13	–	1	1	–	–	–	2	4	–	4	27	1895, .	1	7	8	2	7	2	27
Totals for the Months,	20	32	24	4	3	1	2	6	8	20	18	21	159	Totals for the Stations,	30	33	25	31	24	16	159

TABLE IV., showing the Distribution of the Schizopoda, as indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Numbers of the Records for each Month of each Year.												Number of Records for years and stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	1	1	–	–	–	–	–	1	–	–	1	–	4
	1890, .	–	1	1	–	–	–	–	–	–	1	–	1	4
	1891, .	1	1	1	1	–	–	–	–	–	1	–	–	5
	1892, .	1	1	1	–	–	–	–	–	1	–	1	1	6
	1893, .	2	1	–	1	–	–	–	–	2	1	1	–	8
	1894, .	1	1	–	–	–	–	–	1	–	–	–	1	4
	1895, .	–	–	–	1	–	–	–	–	–	–	–	1	2
Number of Records for all the Months,		6	6	3	3	–	–	–	2	3	3	3	4	33
III.	1889, .	1	–	–	–	–	–	–	–	–	–	1	–	2
	1890, .	–	1	1	1	–	–	1	–	–	1	–	1	6
	1891, .	1	1	–	2	–	2	–	–	1	1	1	1	10
	1892, .	–	1	1	2	–	–	–	–	–	–	–	1	5
	1893, .	1	2	–	–	–	–	–	–	–	1	2	2	8
	1894, .	–	1	–	–	–	–	–	1	–	–	–	3	5
	1895, .	–	1	–	–	–	–	–	–	–	1	–	1	3
Number of Records for all the Months,		3	7	2	5	–	2	1	1	1	4	4	9	39
IV.	1889, .	1	–	–	–	–	–	–	–	–	–	1	–	2
	1890, .	–	1	2	–	–	–	1	–	–	1	–	2	7
	1891, .	1	1	1	1	–	–	–	–	–	1	1	–	6
	1892, .	–	1	1	–	–	–	–	–	–	–	–	1	3
	1893, .	2	–	–	–	–	–	–	–	–	1	1	–	4
	1894, .	–	1	–	–	–	–	–	–	–	–	–	–	1
	1895, .	1	1	–	–	–	–	–	–	–	2	–	2	6
Number of Records for all the Months,		5	5	4	1	–	–	1	–	–	5	3	5	29

TABLE IV.—*continued.*

Three Outer Stations.	Years.	Number of Records for each Month of each Year.												Number of Records for years and stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	–	1	–	–	–	1	–	1	–	1	1	–	5
	1890, .	–	1	–	–	–	–	–	–	1	1	1	1	5
	1891, .	–	–	1	1	1	–	–	–	–	–	1	–	4
	1892, .	1	1	1	1	–	–	–	–	1	1	1		8
	1893, .	2	–	1	–	–	–	–	–	–	1	1	1	6
	1894, .	–	1	–	1	–	–	–	1	–	–	–	–	3
	1895, .	–	1	–	–	–	–	–	–	–	–	–	–	1
Number of Records for all the Months,		3	5	3	3	1	1	–	2	2	4	5	3	32
VIII.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	1	1	1	–	–	–	–	–	–	–	1	4
	1891, .	–	–	–	1	1	2	1	–	1	–	1	–	7
	1892, .	–	1	–	1	1	–	–	–	1	1	–	3	8
	1893, .	1	–	–	–	–	–	–	–	–	–	–	2	3
	1894, .	1	1	–	–	–	–	–	–	–	–	–	–	2
	1895, .	–	1	–	–	–	–	–	–	1	–	–	1	3
Number of Records for all the Months,		2	4	1	3	2	2	1	–	3	1	2	7	28
IX.	1889, .	1	–	–	–	–	1	–	–	–	–	1	–	3
	1890, .	–	1	1	1	–	–	–	1	–	1	–	–	5
	1891, .	–	–	–	–	–	–	–	–	–	–	–	–	–
	1892, .	1	1	–	1	2	–	1	–	–	–	–	2	8
	1893, .	1	–	1	–	–	–	–	–	–	1	–	1	4
	1894, .	–	1	–	–	–	–	–	–	–	–	–	–	1
	1895, .	–	1	–	1	1	–	–	–	1	–	–	1	5
Number of Records for all the Months,		3	4	2	3	3	1	1	1	1	2	1	4	26

It will be observed from the various Tables, and also from what has been already stated concerning the distribution of these crustaceans in the Firth of Forth district, that, generally speaking, they are much more numerous in the winter and spring months than in summer; and not only is it the case that a greater variety of species appear to be present in the estuary during those colder months, but it is evident that some of them at least are also individually much more numerous. The recorded results of the *Garland* researches, even during that part of the year which seems to be most favourable to the presence of these organisms, shows that their movements are more or less erratic. On February 14, 1890, Euphausiidæ are recorded as "common" in a bottom tow-net gathering at Station V., but at Station VII., a little to the south of Station V., trawled the previous day, they are described as "very rare," while, on the other hand, the Mysidæ were more common, and in much greater variety, at this station. Moreover, at Station I., which is in line with Station V., but a little farther west, and also at Stations II., III., and IV., which were all tow-netted within a few days of each other, Euphausiidæ are either altogether absent from the tow-net lists or they are described as "rare." These Schizopods were again present in the Forth in considerable numbers in the following March; they were common at Stations I., III., IV., VIII., and IX., but few or rare at Stations II., V., VI., and VII. During the following summer Euphausiidæ were entirely absent from, or were very scarce in, the tow-net gatherings which were then collected; but the records for the ensuing month of October describe these organisms as frequent at some of the stations during that month, and they continue to be represented in the tow-net gatherings in varying numbers, from one or other of the stations, all through the winter and on to the spring of 1891. During the summer and winter months of that year comparatively few records of the Euphausiidæ occur in the lists of tow-net gatherings, and not till the beginning of 1892 is there much increase in the number of the records; but, though in February and March there is a decided increase, the captures of them even then are usually described as "few" or "rare." With one or two exceptions, Schizopods continued to be scarce in the tow-net gatherings till the winter of 1893-94, when they appear to have become more than usually numerous, and, in a considerable proportion of the gatherings collected during December and January of that winter, they are referred to as "common" or "frequent." With the advent of summer, however, and from that time on into 1895, the numbers of these crustaceans are again considerably reduced. From a study of all the facts at our disposal in the published records in the Fishery Board's Annual Reports for 1889 to 1896, there seems to be a fair amount of evidence tending to show the existence of a more or less regular yearly increase and decrease in the numbers of Schizopoda present in the estuary of the Forth, but the reason of this increase and decrease is not sufficiently clear to permit at present of a satisfactory explanation.

Besides this apparent yearly variation referred to, there also appears to be a fluctuation, which may or may not be regular, that extends over a longer time. I refer to the presence of Schizopoda in considerable numbers in the winter of 1889-90, and again in the winter of 1893-94; but to ascertain whether this variation is merely accidental or not would have required the investigations to be carried on over a much longer period than they have been. In considering this question of the seasonal variations of the Schizopoda, I have dealt mainly with the Euphausiidæ, because this family is the one most numerously represented in the Firth of Forth, and the one which has shown the greatest tendency to a regular periodic increase and decrease. The Mysidæ, also, to some extent show a similar tendency to variation, but the variation is scarcely so well marked as in the case of Euphausiidæ.

(*c*) CUMACEA.

The species of the Cumacea which have been identified are:—

Iphinoë trispinosa (Goodsir).
Cumopsis goodsiri (V. Beneden).
Leucon nasicus, Kroyer.
Eudorella truncatula (Spence Bate).
Diastylus rugosa, G. O. Sars.
Pseudocuma cercaria (V. Beneden).
Campylaspis rubicunda, Lilljeborg.
Petalosarsia declivis, G. O. Sars.

Others are recorded simply under the family or generic names. As these crustaceans usually live on or close to the bottom of the water, the records of them in the tow-net lists are, as might be expected, comparatively few, and may be briefly stated as under:—

Iphinoë trispinosa is only recorded for Station I. in July 1889, and for the same station in February and July in 1890.

Cumopsis goodsiri. The only record for the species is for Station III. in September 1891.

Leucon nasicus. In 1890 this species is recorded for Station I. in April, for Station V. in March, and for Station VIII. in December; in 1892, for Station V. in April, and for Station VIII. in May 1895.

Eudorella truncatula. The records for this species are four in number, one for Station V. in September and one for Station VIII. in December 1890; one for Station I. in February 1892, and one for the same station in June 1893.

Diastylus rugosa is recorded under its full name only for Station I. in April 1890, and for Station V. in March 1891; but there are several records of *Diastylus* sp. included in the additional references to the group under the more general name of Cumacea, etc.

Pseudocuma cercaria. This is a moderately common Cumacean, though, for the reason stated about the habits of these creatures, its name does not occur very frequently in the lists of tow-net fauna. The records are as follows:—In 1890 there are four in April—viz., one for Stations I., V., VIII., and IX., and it is recorded again for Station IX. in August and October. In 1891 there is a record for Station IX. in February, and for the same station again in September, and there is also one for Station VIII. in September. In 1892 there is a record for Station I. in January, and again for the same station in September. There is only one record for 1893—viz., for Station VIII. in April. In 1894 there are records of *Pseudocuma* for Station V. in August, and for Station IX. in February and April; and in 1895 for Station I. in April and October, for Station III. in October, for Station V. in April and August, and in the same two months for Station IX.

Campylaspis rubicunda. This species, which at that time had not been recorded for Britain, was observed at Station IX. in April 1893, and at Station V. in 1894.

Petalosarsia declivis, another rare Cumacean, was observed at the same time and place as *Campylaspis.* This concludes the records of the named species, but there are several other records of Cumaceans under the more general names of Cumacea, *Cuma*, etc., which I shall now refer to.

The records of Cumaceans under these general names are as follows:— In 1890 the first is for Station V. in March; in April there are records for Stations III., VIII., and IX., and for Station VIII. in December. In 1891 the records are—one for Station VIII. in February, for Station I. in March, for Station VIII. in April, and for Station III. in November. In 1892 there is a record for Station VIII. in March, for Station IX. in May, for Stations V. and IX. in July, for Station VIII. in September, and for Station IX. in December. In 1893 there are four records of Cumacea—viz., two in June for Stations I. and V., one in August for Station V., and one in October for Station IX. The only records in 1894 are—one for Station V. in February, and another for Station IX. in the same month. There are five records in 1895, one for Station IV. in February, one for Stations III., VIII., and IX. in February, and one for Station VIII. in December.

There does not appear to be any feature of special interest in the distribution of the Cumacea as brought out by the published records, except that a few of the species are rare or new in the British seas.

(*d*) ISOPODA.

The next group of organisms that fall to be noticed is the Isopoda. This group is represented in the tow-net lists by six species, the names of which are as follow:—

Gnathia (?) *maxillaris* (M. Edw.).
Eurydice pulchra, Leach.
Idothea baltica (Pallas).
Idothea emarginata (Fabr.).
,, *linearis* (Linn.).
Janira maculosa, Leach.

With the exception of *Idothea baltica*, these Isopods were all extremely rare in the tow-net gatherings under consideration, and the records for them are as under:—

Gnathia (?) *maxillaris* is recorded once in 1890, for Station VIII. in March.

Eurydice pulchra is recorded in the same year for Station III. in November.

Idothea baltica is recorded in 1889 for Station VIII. in February, and for Station IX. in January. In 1890 the same species is recorded in April for Stations IV. and V., and again for Station V. in October. In 1891 it is recorded for Station I. in January and April, and for Station IV. in March. It is recorded again for Station IV. in May 1892. In 1893 it is recorded in February for Station III., and in November for Stations I. and IV. In 1894 there is one record—viz., for Station IV. in April. In 1895 this Isopod is recorded in April for Stations I., III., IV., V., and VIII., and for Station V. in September. It will be seen that nine out of the nineteen records of *Idothea baltica*, or fully 47 per cent., are for the month of April; and it has also further to be noted that, curiously enough, the whole number of the records, with only a single exception, are from surface tow-net gatherings.

Idothea linearis. There is only one record for this species—viz., for Station IV. in January 1893.

Idothea emarginata. There is also only one record for this species—for Station I. in May 1891.

Janira maculosa is also only recorded once, for Station IX. in April 1890.

TABLE V., showing the Distribution of the Isopoda :—

Stations.	Years.	Months.												Total for Years.	Total for Stations	
		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.			
I.	1891	1	–	–	1	1	–	–	–	–	–	–	–	3	5	Three Inner Stations.
	1893	–	–	–	–	–	–	–	–	–	–	1	–	1		
	1895	–	–	–	1	–	–	–	–	–	–	–	–	1		
III.	1890	–	–	–	–	–	–	–	–	–	–	1	–	1	3	
	1893	–	1	–	–	–	–	–	–	–	–	–	–	1		
	1895	–	–	–	1	–	–	–	–	–	–	–	–	1		
IV.	1890	–	–	–	1	–	–	–	–	–	–	–	–	1	7	
	1891	–	–	1	–	–	–	–	–	–	–	–	–	1		
	1892	–	–	–	–	1	–	–	–	–	–	–	–	1		
	1893	1	–	–	–	–	–	–	–	–	–	1	–	2		
	1894	–	–	–	1	–	–	–	–	–	–	–	–	1		
	1895	–	–	–	1	–	–	–	–	–	–	–	–	1		
V.	1890	–	–	–	1	–	–	–	–	–	1	–	–	2	4	Three Outer Stations.
	1895	–	–	–	1	–	–	–	–	1	–	–	–	2		
VIII.	1889	–	1	–	–	–	–	–	–	–	–	–	–	1	3	
	1890	–	–	1	–	–	–	–	–	–	–	–	–	1		
	1895	–	–	–	1	–	–	–	–	–	–	–	–	1		
IX.	1889	1	–	–	–	–	–	–	–	–	–	–	–	1	2	
	1890	–	–	–	1	–	–	–	–	–	–	–	–	1		
Total for Months,		3	2	2	10	2	–	–	–	1	1	3	–	24	24	

(*e*) AMPHIPODA.

We shall now proceed to consider the Amphipoda recorded in the lists of tow-net fauna, and at the very outset we meet with a marked differentiation in regard to the distribution and numbers of certain of the species. Twenty-two species of the Amphipods mentioned in the lists of tow-net gatherings are more or less fully defined by name. The distribution, as regards the numbers and the frequency of three of the species, is so different from the others as to indicate a more or less decided difference in their habits and mode of life. The three species I refer to are *Hyperia galba*, *Hyperoche tauriformis* (Spence Bate), and *Parathemisto oblivia.* Moreover, while these three differ more or less distinctly from the other Amphipods mentioned in the tow-net lists, they are also in their own habits somewhat dissimilar to each other. *Parathemisto*, for example (and perhaps also *Hyperoche*), is to a large extent a free-swimming species; on the other hand, the *Hyperiæ* are also characterised as messmates of large Medusæ, and live a considerable part of their lives under the shelter afforded them by these curious organisms. Hence the distribution of *Hyperia* in the Firth of Forth depends to some extent on the presence or absence of Medusæ, whereas *Parathemisto* being a "free swimmer," its movements are not so limited as those of the other.

The following is a list of the Amphipods referred to by name in the lists of tow-net fauna:—

Hyperia galba (Montagu).
Hyperoche tauriformis (Bate).
Parathemisto oblivia (Kroyer).
Euthemisto (?) *compressa* (Goës).
Callisoma crenata (Bate).
Hippomedon denticulatus (Bate).
Bathyporeia sp.
Ampelisca sp.
Stenothoë marina (Bate).
Argissa hamatipes (Norman).
Metopa alderi, Bate.
Perioculodes longimanus (Bate).
Iphimedia obesa, Rathke.
Apherusa bispinosa (Bate).
,, *borealis* (Boeck).
Paratylus swammerdami (M. Edw.).
Dexamine sp.
Melphidippella macera (Norman).
Amathilla homari (Fabr.).
Gammarus sp.
Gammaropsis erythrophthalma, Lillj.
Pariambus typicus (Kr.).

As it is not my intention to describe in detail the distribution of all the Amphipods named in the list, I shall confine my remarks chiefly to the Hyperiidæ, because of their great importance both numerically and as fish food.

Hyperia galba. This Amphipod is occasionally present in the Firth of Forth, but usually in limited numbers, and the records of its occurrence seem to indicate that it is as frequently captured by the bottom tow-net as it is by the surface net. In 1889 the records of it for the selected stations are very few. It is recorded in the bottom tow-net lists for July, and again in November. The November record describes it as common. It is recorded for Station V. in August and November, and described as frequent in the bottom tow-net gatherings and few in the November surface-net gatherings; and it occurred sparingly in the bottom tow-net gatherings from Stations VIII. and IX. in August. But the infrequency of the records of this and other species in 1889 is no doubt partly due to there being no lists of tow-net fauna for March, April, and May (with one exception—viz., for Station V. for surface net in May), and for nearly all the months of October and December. In 1890, though there are frequent records of the occurrence of Amphipods under the name of *Hyperia* sp., *H. galba* is only two or three times noted, once in February for Station I., in July for Station III., and in December for Station VIII. The species referred to under the name of *Hyperia* sp. is probably *Hyperoche tauriformis,* recorded in 1891 *et seq. ann.* In 1891 no direct reference to *Hyperia galba* occurs among the tow-net faunal lists. There are five records in 1892, but one or two of them are doubtful. In 1893 there are two records for Station III., one in August and one in November, that appear to refer to *Hyperia galba.* There are no records of it in 1894, but there are eight in 1895, one for Station I. in October and December, two (one surface and one bottom) for Station III. in October, one for Station IV. in August and October, one for Station V. in September, and one for Station VIII. in October.

Hyperoche tauriformis. This species, which is the *Hyperia tauriformis* of Spence Bate, was recognised as a member of the Forth fauna in 1891, and has been observed more or less frequently every year since. In previous tow-net tests it was recorded simply as *Hyperia* sp., and the records of Amphipoda under that name in Part III. of the Annual Reports probably refer chiefly to *Hyperoche,* though they may also occasionally include immature forms of *Hyperia galba* which could not at the time be otherwise satisfactorily disposed of. In the Report for 1891 there are about fourteen to sixteen records of this Amphipod, chiefly from Stations V., VIII., and IX. In 1892 there are eighteen records. They extend over nearly all the stations, and the majority of them are for the autumn and winter months. The following are the records for 1892 :—For Station I. in November and December; for Station III. in July, October, and November; for Station IV. in October, November, and December; for Station V. in February and March, and again in October and November; for Station VIII. in July, October, and November; and for Station IX. in October and December. In 1893 the number of records for *Hyperoche tauriformis* is fourteen. It was recorded for Station I. in January, June, August (surface and bottom tow-nets), and September (surface and bottom tow-nets); for Station III. in June (surface and bottom tow-nets); for Station V. in August and September; for Station VIII. in July and September; and for Station IX. in January and August. There are ten records in 1894—viz., for Station I. in August and November; for Station III. in June, August (surface and bottom tow-nets), and in November (surface and bottom tow-nets); for Station IV. in February, and for Station V. in June and August. In 1895 there are eighteen records, divided as follows :—One for Station I. in October and December (for surface and bottom tow-nets); for Station III. in February, August, October (for surface and bottom tow-nets), and December (also for surface and bottom tow-nets); for Station IV. in October (for surface and bottom tow-nets) and December (also for surface and bottom tow-nets); for Station V. in February; for Station VIII. in February, October, and December; and for Station IX. in December.

Parathemisto oblivia. This Amphipod was more common and more generally distributed in the estuary than any of the other species, and it is one of the species that enter largely into the food of certain fishes, as the herring. At times the stomachs of herring contain large numbers of this crustacean.

In 1889—the first of the series of seven years—the records of *Parathemisto* are few, there being only seven for the whole of the year; but there are, as already explained, several of the months of 1889 for which there are no lists of tow-net fauna, and this no doubt accounts to a considerable extent for the records for that year being so few in number. Among the records for 1889 there is one for Station I. in January and another for Station IV.; for Station V. the records are, one in January and two in February, and one also for Station VIII. in January, and for Station IX. in January and November.

In 1890 there are comparatively few records. *Parathemisto* was scarce in the surface and bottom tow-nets. For Station III. in April (in the surface tow-net), and at Station I. in May, it was rare; in the surface net for Station IV. in December; at Station V. it was obtained in April, November, and December. The December record includes both the surface and bottom tow-net gatherings. There are also the following records for Station VIII.—viz., two in April and December (surface and bottom tow-nets), and one in May and in August (bottom tow-net only). There are two records for Station IX., one in April and one in August.

In 1891 the records of *Parathemisto* are much more frequent than in the two preceding years. There are twelve records for Station I., one in January, two in February, March, and April, one in May, June, and October, and two in November. There are also twelve records for Station III., one in January, February, and April, two in May, one in June, August, and October, and two in November and December. There are ten records for Station IV., two in January, February, and March, one in April, two in May, and one in June. There are ten records for Station V., two in February and March, one in April and May, and two in November and December. The records for Station VIII. are two in February, one in June, and two in November; while those for Station IX. are two in February, and one in April, May, and November—the total number of records for 1891 being fifty-four.

The records of *Parathemisto* for 1892 include the following, viz.:—Two for Station I. (surface and bottom tow-nets) in January, February, and March, and one in April for the bottom tow-net, and in November and December for the surface tow-net. The records for Station III. are two in January, February, and March, and one in October, November, and December. For Station IV. there are two records for January, February, and March, and one for April, November, and December. For Station V. there is one in January and February, two in March, April, and October, and one in November and December. The records for Station VIII. are two in January, February, and March, one in May, June, July, and October, and two in December; and for Station IX. there are two records in July, February, and March, one in April, May, July, and October, and two in December. Altogether there are sixty records of *Parathemisto* for 1892, and over fifty of them occur in the first three and last three months of the year. It may also be noted that the records for Stations I., III., and IV. describe the species as common in the surface tow-nets in January or February, while the records for Stations VIII. and IX. describe it as common in the bottom tow-nets in January.

In 1893 the records of *Parathemisto* are much fewer in number than for the previous year. Those for Station I. are two in January and one in April, October, and November. For Station III. there is one in January, February, and October, and two in December. The December records describe *Parathemisto* as frequent in the surface and common in the bottom tow-net. For Station IV. there is one record in January, February, April, and May, two in October, and one in November. For Station V. there is one in February and June, and two in October and December. For Station VIII. there is one in January, April, May, and October, and two in December; while for Station IX. there is one in

April, two in October, and two in December. The October records for Station IX. describe the species as common in the surface tow-net and frequent in the bottom net, and in December as frequent in both nets There are in all thirty-four records of *Parathemisto* for 1893, twenty seven of them being for the first three or last three months.

In 1894 the number of records are as follow :—For Station I. there is one in February, two in April and August, and one in November. For Station III. there is one in February and April, two in August, one in November, and two in December. For Station IV. there is only one record—viz., for surface tow-net in February, in which *Parathemisto* is described as common. There are only two records for Station V.—viz., for surface and bottom tow-nets in February. There are three records for Station VIII., one in January and February, and one in April. The only record for Station IX. is one in February. The number of records of *Parathemisto* for 1894 is twenty, twelve of which are for the first two and last two months, the other eight being divided equally between April and August.

In 1895 the records for Station I. are one in February and two in December, and in the surface tow-net record for December *Parathemisto* is described as common. For Station III. there is one in February and April, and two in December. For Station IV. there is one record in February and one in December. There is one record in April for Station V. For Station VIII. there is one in February and April, and two in December; while for Station IX. the records are two in February and one in December—or seventeen records altogether for 1895, thirteen, or fully 70 per cent., of them being for the two months February and December.

The following Table shows the distribution of the records of *Parathemisto* as described in the preceding notes :—

TABLE VI., showing the Distribution of *Parathemisto*, as indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Months.												Total for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.	
I	1889, .	1	–	–	–	–	–	–	–	–	–	–	–	1
	1890, .	–	–	–	–	1	–	–	–	–	–	–	–	1
	1891, .	1	2	2	2	1	1	–	–		1	2	–	12
	1892, .	2	2	2	1	–	–	–	–	–	–	1	1	9
	1893, .	2	–	–	1	–	–	–	–	–	1	1	–	5
	1894, .	–	1	–	2	–	–	–	2		–	1	–	6
	1895, .	–	1	–	–	–	–	–	–	–	–	–	2	3
Totals for the Months, ...		6	6	4	6	2	1	–	2	–	2	5	3	37

TABLE VI.—*continued.*

Inner Stations—*continued.*	Years.	Months.												Total for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
III.	1889,	–	–	–	–	–	–	–	–	–	–	–	–	–
	1890,	–	–	–	2	–	–	–	–	–	–	–	–	2
	1891,	1	1	–	1	2	1	–	1	–	1	2	2	12
	1892,	2	2	2	–	–	–	–	–	–	1	1	1	9
	1893,	1	1	–	–	–	–	–	–	–	1	–	2	5
	1894,	–	1	–	1	–	–	–	2	–	–	1	2	7
	1895,	–	1	–	1	–	–	–	–	–	–	–	2	4
Totals for the Months, ...		4	6	2	5	2	1	–	3	–	3	4	9	39
IV.	1889,	1	–	–	–	–	–	–	–	–	–	–	–	1
	1890,	–	–	–	–	–	–	–	–	–	–	–	1	1
	1891,	2	2	2	1	2	1	–	–	–	–	–	–	10
	1892,	2	2	2	1	–	–	–	–	–	–	1	1	9
	1893,	1	1	–	1	1	–	–	–	–	2	1	–	7
	1894,	–	1	–	–	–	–	–	–	–	–	–	–	1
	1895,	–	–	–	1	–	–	–	–	–	–	–	1	2
Totals for the Months, ...		6	6	4	4	3	1	–	–	–	2	2	3	31

Three Outer Stations.	Years.	Months.												Total for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889,	1	2	–	–	–	–	–	–	–	–	–	–	3
	1890,	–	–	–	1	–	–	–	–	–	–	1	2	4
	1891,	–	2	2	1	1	–	–	–	–	–	2	2	10
	1892,	1	1	2	2	–	–	–	–	–	2	1	1	10
	1893,	–	1	–	–	–	1	–	–	–	2	–	2	6
	1894,	–	2	–	–	–	–	–	–	–	–	–	–	2
	1895,	–	–	–	1	–	–	–	–	–	–	–	–	1
Totals for the Months, ...		2	8	4	5	1	1	–	–	–	4	4	7	36

TABLE VI.—*continued.*

Outer Stations—*continued.*	Years.	Months.												Total for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
VIII.	1889, .	1	–	–	–	–	–	–	–	–	–	–	–	1
	1890, .	–	–	–	2	1	–	–	1	–	–	–	2	6
	1891, .	–	2	–	–	–	1	–	–	–	–	2	–	5
	1892, .	2	2	2	–	1	1	–	–	–	1	–	2	11
	1893, .	1	–	–	1	1	–	–	–	–	1	–	2	6
	1894, .	1	1	–	1	–	–	–	–	–	–	–	–	3
	1895, .	–	1	–	1	–	–	–	–	–	–	–	2	4
Totals for the Months, ...		5	6	2	5	3	2	–	1	–	2	2	8	36
IX.	1889, .	1	–	–	–	–	–	–	–	–	–	1	–	2
	1890, .	–	–	–	1	–	–	–	1	–	–	–	–	2
	1891, .	–	2	–	1	1	–	–	–	–	–	1	–	5
	1892, .	2	2	2	1	1	–	1	–	–	1	–	2	12
	1893, .	–	–	–	1	–	–	–	–	–	2	–	2	5
	1894, .	–	1	–	–	–	–	–	–	–	–	–	–	1
	1895, .	–	1	–	–	–	–	–	–	–	–	–	1	2
Totals for the Months, ...		3	6	2	4	2	–	1	1	–	3	2	5	29

The Table shows that the total number of records for Stations I., III., V., and VIII. is nearly the same; and it is of interest to note that Stations IV. and IX., which are also nearly equal but show a smaller number of records than the others, might have been expected to have yielded very different results, as the first is an inshore station, while the other is the farthest seaward of all the Forth stations, being situated considerably east of the May Island. Another point of interest is, that besides the comparative absence of these Amphipods during the summer months there is evidence of a somewhat remarkable increase of those Crustaceans in the Forth in 1891 and 1892 compared with other years. With reference to the remarkable increase in the number of *Parathemisto* in the Forth during these two years, it is specially worthy of note that in February 1892 an immense shoal of *Euthemisto compressa*—a species closely allied to *Parathemisto* in structure and habits—was observed off the Yorkshire coast. So great in number were they that the sea was described as "literally alive with them," and it is stated that "heaps" of them "were afterwards washed ashore by sea-winds, and afforded a feast for starlings and other frequenters of the tidal line." * Some of these *Euthemisto* found their way into the Forth estuary, and are mentioned among the tow-net records for that year. They were first observed in the Forth in February, and they either remained in the estuary all the summer or returned in the autumn, for they were observed again in November.

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* T. H. Nelson in 'Naturalist' for May 1892.

Whether this irruption of the Hyperiidæ was merely accidental and temporary, or due to a periodic migration at more or less distant intervals of time, the records are not sufficiently extensive to show. Whatever be the reason, there seems to be no doubt that some time during 1891 and 1892 there was a greater number than usual of these Crustaceans off our East Coast, part of which found their way inshore, with the result that the number of records of *Parathemisto* was increased beyond those of the previous or following years.

In the following analysis of the Table, some of the results referred to are more clearly brought out—the three formulæ subjoined show the total numbers of the records (1) for the stations, (2) the months, and (3) the years, thus :—

Formula (1) shows the total number of the records of *Parathemisto* for each of the stations for all the months and years :—

Numbers of the Stations, - - - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station, -	37	39	31	36	36	29

Formula (2) shows the total number of the records of *Parathemisto* for each of the months for all the years, (*a*) for Stations I., III., and IV. ; (*b*) for Stations V., VIII., and IX. ; and (*c*) for all the six stations : —

Names of the Months, - - - - - -		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Inner Stations, -	16	18	10	15	7	3	0	5	0	7	11	15
	(*b*) the Outer Stations, -	10	20	8	14	6	3	1	2	0	9	8	20
	(*c*) all the Six Stations, -	26	38	18	29	13	6	1	7	0	16	19	35

Formula (3) shows the total number of the records of *Parathemisto* for each year, for (*a*) the inner stations, I., III., and IV. ; (*b*) the outer stations, V., VIII., and IX. ; and (*c*) for all the six stations :—

Numbers of Years, - - - -		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for	(*a*) the Inner Stations, -	2	4	34	27	17	14	9
	(*b*) the Outer Stations, -	6	12	20	33	17	6	7
	(*c*) all the Six Stations, -	8	16	54	60	34	20	16

Euthemisto compressa. This species (referred to above) was recorded for the first time in the Firth of Forth in the "Tenth Annual Report of the Fishery Board for Scotland," from specimens obtained at Station V. in February 1892. It was collected again in the same year in November; and the next record of it is in November 1893, when it was obtained at Station V.

The other Amphipods mentioned in the list are, with the exception of *Paratylus* and *Apherusa,* only occasionally referred to among the records of tow-net invertebrates, and are therefore, except from a natural history point of view, of less importance than those already mentioned. Consequently I do not propose to enter very minutely into the consideration of their distribution.*

Callisoma crenata. There are few records of this species, and they extend from 1890 to 1895.

Hippomedon denticulatus is only recorded once among the tow-net lists for the selected stations—viz., for Station IX. in February 1894.

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* A tabulated list of species at the end of this paper shows some further details of the distribution of these Amphipods.

Bathyporeia and *Ampelisca* have been recorded, but the species were apparently not identified.

Stenothoë marina has one or two records, but it appears to have been comparatively rare in the tow-net gatherings under consideration.

Argissa hamatipes is occasionally recorded in the lists of tow-net invertebrates collected at the three outer stations, but less frequent in those collected at the inner stations.

Metopa alderi appears to have been comparatively frequent at nearly all the stations.

Perioculodes longimanus is recorded chiefly from the outer stations.

Iphimedia obesa is only recorded once—in 1892 for Station V. in January.

Apherusa (two species) and *Paratylus* are referred to several times in the lists of tow-net invertebrates; neither of them appears to be rare, though less common than some of the others.

Melphidippella macera is only once recorded—viz., at Station VIII. in March 1892.

Amathilla homari is also recorded once—viz., for Station IV. in December 1892.

Gammaropsis erythrophthalmus is recorded once—for Station V. in December 1890.

Dulichia sp. and *Pariambus typicus* are both rarely mentioned among the lists of tow-net gatherings.

(*f*) CLADOCERA.

Evadne nordmanni is recorded from nearly all the six stations, and was occasionally moderately frequent.

Podon (?) *polyphemoides*, though not so common as *Evadne*, is recorded several times, and for at least four different stations.

(*g*) COPEPODA.

The Copepoda, though usually present in nearly all the tow-net gatherings, being sometimes common or even abundant, do not usually show much variety of species. The following is a list of the Copepods recorded in the various tow-net gatherings collected during the seven years at the six selected stations:—

Calanus finmarchicus (Gunner).
Pseudocalanus elongatus, Boeck.
Temora longicornis (Müller).
Centropages hamata, Lillj.
Centropages typicus, Kr.
Metridia hibernica (B. & R.).
Candace pectinata, Brady.
Acartia sp. (? *Clausii* and *longiremis*).
Anomalocera patersoni, Templ.
Parapontella brevicornis (Lub.).
Oithona (?) *similis*, Claus.
Thalestris longimanus, Claus.
Thalestris serrulatus, Brady.
Alteutha depressa (Baird).
Dermatomyzon nigripes (B. and R.).
Monstrilla sp.
Caligus rapax, Müller.

A few of the species named above are found occurring with more or less frequency in nearly all the lists of tow-net invertebrates, but the larger number of them were infrequent or rare, and it is those only that are of numerical importance that need be specially referred to here. The first of them that I propose to notice is *Calanus finmarchicus*. *Calanus finmarchicus* is, because of its numbers and its general distribution, one of the most important of the group to which it belongs, at least in the British seas. Being usually so numerous, it no doubt furnishes a rich supply of food to the young of all kinds of fishes, and, as a matter of fact, it frequently forms the principal food of the herring. This species is, as a rule, usually more numerous than the other pelagic Copepods, and it occurs at times in considerable abundance in the estuary. Its distribution, as indicated by the tow-net records, is as follows:—In 1889 *Calanus* is recorded twice for Station I. in January; once in July, August, October, and November for Station III.; once in January, July, and August for Station IV.; once in January, May, June, August, and September for Station V., while for the same station in November *Calanus* is recorded as abundant in the surface and frequent in the bottom tow-nets; for Station VIII. it is recorded once in January, twice in June and July, once in August, and once in November; for Station IX. there are two records in June, one in August, and two in November. In the surface tow-net record for November *Calanus* is described as abundant, and as common in the bottom tow-net.

In 1890 the records of *Calanus* for Station I. are two in February, March, April, May, July, October, and November, and one in December. It is described as abundant in one and common in four of these gatherings. The records for Station III. are two in February, March, April, May, July, October, and November, and one in August; for Station IV. there are two records in March, May, November, and December, and one in February, April, July, August, and October. The records for Station V. are two in February, March, April, May, September, October, November, and December, and one in July. For Station VIII. there are two records in March, April, May, September, and December, and one in February, July, and October; while for Station IX. there are two records in March, April, May, October, and December, and one in February, July, and September. The records for *Calanus* in 1891 are for Station I. two in February, March, April, May, June, and August, and one in January, July, October, and November. For Station III. there are two records in February, April, May, June, July, and December, and one in January, August, September, October, and November. For Station IV. there are two records in January, February, March, April, May, June, and October, and one in August and November. The records for Station V. are two in February, March, April, May, July, October, November, and December, and one in June and August. Station V. having been trawled twice in October adds a third record for that month. There are two records for Station VIII. in February, April, May, June, and November, and one in July, August, September, and October; while for Station IX. there are two records in February, May, June, July, August, and November, and one in April, September, and October—making ninety-seven records in all for 1891. The number of the records of *Calanus* for 1892 is about equal to that of the previous year. Those for Station I. are two in April, May, and December, and one in January, February, March, July, September, and November. For Station III. there are two records in February, March, April, May, November, and December, and one in January, July

September, and October. The records for Station IV. are two in March, April, May, June, October, and December, and one in January, February, July, September, and November. For Station V. there are two records in January, April, May, October, November, and December, and one in March, July, and September. The records for Station VIII. are two in March, April, and September, and one in January, February, May, June, July, and November. In December this station was trawled twice, and furnished four records of *Calanus* for that month. The records for Station IX. are two in January, February, April, May, September, and October, and one in March, June, and July. There are also three records in December, the station having been trawled twice that month.

The records for 1893 are as follows :—For Station I. there are two in January, April, May, September, and November, and one in February, June, July, August, October, and December. For Station III. there are two in January and December, and one in February, May, June, July, August, September, October, and November. For Station IV. there are two in January, February, April, June, October, and November, and one in May and December. There are for Station V. two records in February, May, August, October, and December, and one in March, June, July, September, and November. There are two records for Station VIII. in January, April, July, and December, and one in February, May, August, September, and October, while for Station IX. there are two records in January, February, May, June, July, October, and December, and one in April and August.

The records of *Calanus* for 1894, which are fewer than for the three preceding years, include two for Station I. in April and December, and one in January and February. There are two for Station III. in August, and one in February, April, and June, while in December there are four records owing to the station having been twice trawled that month. For Station IV. there are two records in April and one in January and February. The records for Station V. are two in February and April and one in August. For Station VIII. there are two records in February and one in January, April, and August, and those for Station IX. are two in February and April. The records for this year number thirty-four.

The records of *Calanus* for 1895, which are also few in number, include two for Station I. in April and December, and one in February, May, and October. There are two for Station III. in February, April, October, and December, and one in May. There are two for Station IV. in February, October, and December, and one in January, April, and May. The records for Station V. are two in February, April, May, and August, two for Station VIII. in February, May, October, and December, and one in April and September, while for Station IX. there are two records in February, April, and December, and one in May, August, and September. The number of records for 1895 is fifty, while the total number for the seven years is four hundred and eighty-four.

The distribution of *Calanus finmarchicus*, as described in the preceding notes and shown by the annexed tabular arrangement of the number of records, is more uniform throughout the six stations than that of *Parathemisto.* It may be observed that there is a tendency towards an increase in the number of records during the earlier months, and also to a small extent during the later months of the year, but this tendency shows itself principally in the greater number of double records for these months: that is, records which include both the bottom and surface tow-net gatherings. This is shown more clearly by the Table.

TABLE VII., giving the Distribution of *Calanus finmarchicus*, as shown by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Number of Records for each Month of each Year.												Totals for Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	2	–	–	–	–	–	1	1	–	1	1	–	6
	1890, .	–	2	2	2	2	–	2	–	–	2	2	1	15
	1891, .	1	2	2	2	2	2	1	2	–	1	1	–	16
	1892, .	1	1	1	2	2	–	1	–	1	–	1	2	12
	1893, .	2	1	–	2	2	1	1	1	2	1	2	1	16
	1894, .	1	1	–	2	–	–	–	–	–	–	–	2	6
	1895, .	–	1	–	2	1	–	–	–	–	1	–	2	7
Total Records for the Months, .		7	8	5	12	9	3	6	4	3	6	7	8	78
III.	1889, .	1	–	–	–	–	1	1	1	–	–	1	–	5
	1890, .	–	2	2	2	2	–	2	1	–	2	2	–	15
	1891, .	1	2	–	2	2	2	2	1	1	1	1	2	17
	1892, .	1	2	2	2	2	–	1	–	1	1	2	2	16
	1893, .	2	1	–	–	1	1	1	1	1	1	1	2	12
	1894, .	–	1	–	2	–	1	–	2	–	–	–	4	10
	1895, .	–	2	–	2	1	–	–	–	–	2	–	2	9
Total Records for the Months, .		5	10	4	10	8	5	7	6	3	7	7	12	84
IV.	1889, .	1	–	–	–	–	–	1	1	–	–	1	–	4
	1890, .	–	1	2	1	2	–	1	1	–	1	2	2	13
	1891, .	2	2	2	2	2	2	–	1	–	2	1	–	16
	1892, .	1	1	2	2	2	2	1	–	1	2	1	2	17
	1893, .	2	2	–	2	1	2	–	–	–	2	2	1	14
	1894, .	1	1	–	2	–	–	–	–	–	–	–	–	4
	1895, .	1	2	–	1	1	–	–	1	–	2	–	2	10
Total Records for the Months, .		8	9	6	10	8	6	3	4	1	9	7	7	78

[TABLE.

TABLE VII.—*continued.*

Three Outer Stations.	Years.	Number of Records for each Month of each Year.												Totals for Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	1	–	–	–	1	1	–	1	1	–	2	–	7
	1890, .	–	2	2	2	2	–	1	–	2	2	2	2	17
	1891, .	–	2	2	2	2	1	2	1	–	3	2	2	19
	1892, .	2	–	1	2	2	–	1	–	1	2	2	2	15
	1893, .	–	2	1	–	2	1	1	2	1	2	1	2	15
	1894, .	–	2	–	2	–	–	–	1	–	–	–	–	5
	1895, .	–	2	–	2	2	–	–	2	–	–	–	–	8
Totals for the Months, . . .		3	10	6	10	11	3	5	7	5	9	9	8	86
VIII.	1889, .	1	–	–	–	–	2	2	1	–	–	1	–	7
	1890, .	–	1	2	2	2	–	1	–	2	1	–	2	13
	1891, .	–	2	–	2	2	2	1	1	1	1	2	–	14
	1892, .	1	1	2	2	1	1	1	–	2	1	–	4	16
	1893, .	2	1	–	2	1	–	2	1	1	1	–	2	13
	1894, .	1	2	–	1	–	–	–	1	–	–	–	–	5
	1895, .	–	2	–	1	2	–	–	–	1	2	–	2	10
Totals for the Months, . . .		5	9	4	10	8	5	7	4	7	6	3	10	78
IX.	1889, .	–	–	–	–	–	2	–	1	–	–	2	–	5
	1890, .	–	1	2	2	2	–	1	–	1	2	–	2	13
	1891, .	–	2	–	1	2	2	2	2	1	1	2	–	15
	1892, .	2	2	1	2	2	1	1	–	2	2	–	3	18
	1893, .	2	2	–	1	2	2	2	1	–	2	–	2	16
	1894, .	–	2	–	2	–	–	–	–	–	–	–	–	4
	1895, .	–	2	–	2	1	–	–	1	1	–	–	2	9
Totals for the Months, . . .		4	11	3	10	9	7	6	5	5	7	4	9	80

This Table also shows that the difference in the total number of records for each of the stations for the seven years is comparatively small. The highest number (86) is for Station V., while the lowest numbers occur at Stations I., IV., and VIII.—each of these stations having a total of 78 records for the seven years. The number of records for each of the stations may be stated as a formula, thus:—

Formula (1) shows the total number of records of *Calanus* for each station for all the seven years:—

	Inner Stations.			Outer Stations.		
Numbers of the Stations, - - - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station, -	78	84	78	86	78	80

The total numbers of the monthly records exhibit a greater amount of divergence than those for the stations as shown by the next formula.

Formula (2) shows the total number of records of *Calanus* for each of the stations for the seven years, (*a*) for the inner stations, I., III., and IV.; (*b*) for the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Names of the Months,		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Inner Stations,	20	27	15	32	25	14	16	14	7	22	21	27
	(*b*) the Outer Stations,	12	30	13	30	28	15	18	16	17	22	16	27
	(*c*) all the Six Stations,	32	57	28	62	53	29	34	30	24	44	37	54

Yet although there is a certain amount of variation, with the exception of one or two months—as March and September—this variation is comparatively trifling, showing that *Calanus* was not only common, but also, on an average, very equally distributed throughout the estuary. The total number of records of this Copepod for the three inner and three outer stations, for the twelve months and for all the seven years, is 240 and 244 respectively, or practically the same for the two groups of stations. Another point which may be noticed here, and which is shown in the Table, is that the totals of the monthly records for the seven years and for each of the six stations for April are, with one exception, exactly alike—the number for April for each station being ten, except at Station I., where the number is twelve. It would also appear from the tabular enumeration of the records that during six out of the seven years (excluding 1889) *Calanus* was more common and generally diffused throughout the district referred to here, in the month of April, than in any of the other months. The reason for this uniformity may not be easily explained. It may be due to a periodic migration of *Calanus*, or to some influence inducing them to crowd more in towards the shore at this season—probably for spawning.

Formula (3) shows the total number of records of *Calanus* for each of the seven years, (*a*) for the inner stations, I., III., and IV.; (*b*) for the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Numbers of the Years,		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for	(*a*) the Inner Stations,	15	43	49	45	42	20	26
	(*b*) the Outer Stations,	19	43	48	49	44	14	27
	(*c*) all the Six Stations,	34	86	97	94	86	34	53

The greatest difference between the yearly totals for the inner and outer stations is that for 1894, while the total number for the seven years for each group of stations shows only a difference of four—the numbers being for the inner stations 240 and for the outer stations 244.

But though *Calanus finmarchicus* is the most common Copepod in the Firth of Forth, there are one or two other species included in the lists of tow-net gatherings which are more or less generally distributed, and at times moderately frequent, and which no doubt compete closely with *Calanus* as important sources of fish-food, especially as the food of young fishes. *Temora longicornis* is one of these; so also, though in a somewhat less degree, are one or two species of *Acartia*—viz., *A. longiremis* and *A. clausii* (both of which are found in the Forth estuary). I do not propose to refer at length to the distribution of these Copepods, as the Tables which follow show by comparison with that of *Calanus* its more important details, as well as some other of the more noticeable differences in this respect between them and that species.

TABLE VIII., showing the Distribution of *Temora longicornis*, as indicated by the Tow-net Records for the Years, Months, and Stations

Three Inner Stations.	Years.	Number of Records for each Month of each Year.												Totals for Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	–	–	–	–	–	–	–	1	–	1	1	–	3
	1890, .	–	–	1	2	2	–	1	–	–	2	2	–	10
	1891, .	–	1	1	2	2	2	1	2	–	–	–	–	11
	1892, .	–	–	–	2	2	2	1	–	1	–	–	–	8
	1893, .	–	–	–	2	2	1	–	–	–	–	–	–	5
	1894, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1895, .	–	–	–	1	2	–	–	–	1	1	–	–	5
Totals for the Months,	. .	–	1	2	10	10	5	3	3	2	4	3	–	43
III.	1889, .	–	–	–	–	–	1	1	1	–	–	–	–	3
	1890, .	–	–	–	2	1	–	1	–	–	1	2	–	7
	1891, .	–	1	–	2	2	2	1	–	–	–	–	–	8
	1892, .	–	–	–	2	2	2	–	–	1	1	–	–	8
	1893, .	–	1	–	–	1	2	1	1	–	1	–	1	8
	1894, .	–	–	–	2	–	1	–	–	–	–	–	1	4
	1895, .	–	1	–	2	2	–	–	–	–	1	–	–	6
Totals for the Months,	. .	–	3	–	10	8	8	4	2	1	4	2	2	44
IV.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	–	–	1	2	–	–	–	–	–	2	1	6
	1891, .	–	1	2	2	2	–	–	2	–	–	–	–	9
	1892, .	–	–	–	2	2	1	–	–	1	2	1	–	9
	1893, .	–	–	–	–	2	1	–	–	–	–	–	1	4
	1894, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1895, .	1	1	–	1	2	–	–	1	–	2	–	–	8
Totals for the Months,	. .	1	2	2	7	10	2	–	3	1	4	4	2	38

[TABLE.

TABLE VIII.—*continued.*

Three Outer Stations.	Years.	Number of Records for each Month of each Year.												Totals for Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	–	–	–	–	1	1	–	2	–	–	1	–	5
	1890, .	–	2	2	2	2	–	1	–	2	2	2	–	15
	1891, .	–	–	2	2	2	–	1	2	–	–	–	–	9
	1892, .	–	–	–	1	2	2	–	–	1	2	–	–	8
	1893, .	–	–	–	–	2	1	1	2	1	–	1	–	8
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	–	–	–	1	2	–	–	–	–	–	–	–	3
Totals for the Months, . .		–	2	4	6	11	4	3	7	4	4	4	–	49
VIII.	1889, .	–	–	–	–	–	1	–	1	–	–	1	–	3
	1890, .	–	–	2	2	2	–	1	–	2	1	–	1	11
	1891, .	–	1	–	2	2	1	1	2	2	–	–	–	11
	1892, .	–	–	–	2	2	2	–	–	1	1	–	–	8
	1893, .	–	–	–	1	1	1	1	1	1	–	–	–	6
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	–	–	–	1	1	–	–	–	1	–	–	–	3
Totals for the Months, . .		–	1	2	8	8	5	3	5	7	2	1	1	43
IX.	1889, .	–	–	–	–	–	–	2	2	–	–	1	–	5
	1890, .	–	–	2	2	1	–	2	–	1	2	–	–	10
	1891, .	–	1	–	2	2	1	–	2	2	1	–	–	11
	1892, .	–	–	–	1	2	2	–	–	1	1	–	1	8
	1893, .	–	–	–	–	1	1	–	1	–	–	–	–	3
	1894, .	–	–	–	1	–	–	–	2	–	–	–	–	3
	1895, .	–	–	–	1	1	–	–	–	1	–	–	–	3
Totals for the Months, . .		–	1	2	7	7	4	4	7	5	4	1	1	43

This Table contains an enumeration of the number of records of *Temora* for all the stations and for the seven years, arranged in the same way as those of *Calanus*. An examination of the Table shows that the distribution of *Temora* differs little from that of *Calanus*, except that the number of records is rather fewer. Like *Calanus*, the highest number of yearly records of *Temora* occur in 1891, 1892, and 1893; and also, like that species, there is with one exception comparatively little difference in the total number of records for each of the stations: the principal difference is found at Station V., where the number is greater, by five records, than the highest number next to it, at Station III., while it is eleven records greater than the minimum number at Station IV. It may also be noted that the station with the highest number of records of *Temora* and *Calanus* is the same—viz., Station V. But the Table shows a slight diversity in the distribution of *Temora* throughout the different months of the year as compared with that of *Calanus*. Thus, the maxima of monthly records are found in April and May, that for May being distinctly higher than that for April, and the minima in January, February, March, and December; while in regard to *Calanus* the maximum number is that for April, while the number for February is smaller than the maximum by only five records. These points are more clearly indicated in the annexed formulæ.

Formula (1) shows the total number of records of *Temora* for each station for all the seven years:—

	(*a*) Inner Stations.			(*b*) Outer Stations.		
Numbers of the Stations, - - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station, -	43	44	38	49	43	43

Formula (2) shows the total number of records of *Temora* for each of the twelve months, (*a*) for the inner stations, (*b*) for the outer stations, and (*c*) for all the six stations:—

Names of the Months, - - - - - - -	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for (*a*) the Inner Stations, - -	1	6	4	27	28	15	7	8	4	12	9	4
(*b*) the Outer Stations, - -	0	4	8	21	26	13	10	19	16	10	6	2
(*c*) all the Six Stations, - -	1	10	12	48	54	28	17	27	20	22	15	6

In the distribution of *Calanus* the month that shows the smallest number of records is September, but in the case of *Temora* the smallest number is that for January, and the proportional difference between the lowest and highest number of records is considerably greater for *Temora* than for *Calanus*.

Formula (3) shows the total number of records of *Temora* for each of the seven years, (*a*) for the inner stations, I., III., and IV.; (*b*) for the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Numbers of the Years, - - - -	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for (*a*) the Inner Stations, -	7	23	28	25	17	6	19
(*b*) the Outer Stations, -	13	36	31	24	17	5	9
(*c*) all the Six Stations, -	20	59	59	49	34	11	28

There seems to be a greater variation in the total numbers for the years in the distribution of *Temora* than is the case with *Calanus*. The above formula shows that in the case of *Temora* the highest total number of yearly records is fully five times greater than the lowest, but in *Calanus* the difference is less than three times; and further, the yearly maxima for *Temora* occur in 1890 and 1891, and in 1891 and 1892 for *Calanus*. The total number of records for *Temora* for the six stations during the seven years is two hundred and sixty.

ACARTIA SP.

The next Table shows the distribution of *Acartia* sp.,* in a manner similar to that of *Calanus* and *Temora*.

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* Careful examination is necessary in order to distinguish the species of *Acartia*, and for various reasons it was not always possible to carry out a minute and sufficiently careful examination of doubtful species on board ship; therefore the specimens of *Acartia* observed were frequently recorded merely under their generic name.

TABLE IX., showing the Distribution of *Acartia* sp., as indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	–	–	–	–	–	1	1	–	–	1	–	3
	1891, .	–	2	1	1	2	1	–	1	–	–	–	–	8
	1892, .	–	1	–	1	–	–	1	–	2	–	–	–	5
	1893, .	–	1	–	1	1	1	–	–	–	–	–	–	4
	1894, .	–	–	–	–	–	–	–	1	–	–	–	1	2
	1895, .	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals for the Months,	. .	–	4	1	3	3	2	2	3	2	–	2	1	23
III.	1889, .	–	–	–	–	–	1	–	1	–	–	–	–	2
	1890, .	–	–	–	–	–	–	1	1	–	1	–	–	3
	1891, .	–	2	–	1	1	2	–	1	–	–	1	–	8
	1892, .	–	–	–	1	–	–	1	–	1	–	2	–	5
	1893, .	–	2	–	–	–	2	–	–	–	–	–	–	4
	1894, .	–	–	–	–	–	1	–	1	–	–	–	–	2
	1895, .	–	–	–	1	1	–	–	–	–	–	–	–	2
Totals for the Months,	. .	–	4	–	3	2	6	2	4	1	1	3	–	26
IV.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	–	–	–	1	–	–	1	–	1	1	–	4
	1891, .	–	1	1	2	–	1	–	1	–	2	–	–	8
	1892, .	–	–	–	–	2	–	1	–	1	2	–	–	6
	1893, .	–	–	–	2	2	2	–	–	–	–	–	–	6
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	–	–	–	1	1	–	–	–	–	–	–	–	2
Totals for the Months,	. .	–	1	1	5	6	3	1	3	1	5	2	–	28

TABLE IX.—*continued.*

Three Outer Stations.	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	–	–	1	–	–	1	–	1	1	1	–	5
	1891, .	–	1	1	1	2	1	–	1	1	1	–	–	9
	1892, .	–	–	–	–	1	1	1	–	–	1	–	–	4
	1893, .	–	–	–	–	1	–	–	2	–	–	–	–	3
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	–	–	–	–	1	–	–	1	–	–	–	–	2
Totals for the Months, . .		–	1	1	2	5	2	2	5	2	3	2	–	25
VIII.	1889, .	–	–	–	–	–	–	–	–	–	–	1	–	1
	1890, .	–	–	1	–	1	–	–	–	1	1	–	–	4
	1891, .	–	2	–	1	1	1	–	2	1	–	1	–	9
	1892, .	–	–	–	–	1	1	1	–	–	1	–	–	4
	1893, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	–	–	–	1	1	–	–	1	–	–	–	–	3
Totals for the Months, . .		–	2	1	2	4	2	1	5	2	2	2	–	23
IX.	1889, .	–	–	–	–	–	–	–	1	–	–	1	–	2
	1890, .	–	–	–	1	–	–	1	–	1	–	–	1	4
	1891, .	–	2	–	2	1	–	–	2	–	–	–	–	7
	1892, .	–	–	–	–	2	1	1	–	–	1	–	–	5
	1893, .	–	–	–	–	1	–	–	–	–	–	–	–	1
	1894, .	–	–	–	–	–	–	–	2	–	–	–	–	2
	1895, .	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals for the Months, . .		–	2	–	3	4	1	2	5	1	1	1	1	21

It will be observed from this Table that the distribution of *Acartia* varies to a greater extent from that of *Calanus* than that of *Temora* was found to do. The greatest number of yearly records of *Acartia* shown in the Table is that for 1891, and not only is the yearly total number for the six stations for 1891 the greatest, but the same thing is observed in the total number of each of the stations for that year. If, on the other hand, a comparison be made between the highest and lowest total numbers for the six stations, the difference is rather less than in *Temora,* and more similar to that observed in *Calanus.* It is also noticeable that *Acartiæ* are comparatively usually more frequent during the summer months. It will be observed, for example, that the highest of the total monthly records for each of the three outer stations are those for May and August; while at Station IV. the highest is that for May, and at Station III. for June; but at Station I. the highest is that for February. The next highest numbers are those for April, May, and August. Some of these points are more clearly indicated by the three formulæ.

Formula (1) shows, as before, the total number of records of *Acartia* for each of the stations :—

	(*a*) Inner Stations.			(*b*) Outer Stations.		
Numbers of the Stations, - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station,	23	26	28	25	23	21

The station with the lowest number is IX., while that with the highest number is IV., the difference between them being seven.

Formula (2) shows the total number of records of *Acartia* for each of the twelve months for the seven years, (*a*) for the inner stations, I., III., and IV.; (*b*) for the outer stations, V., VIII., and IX.; (*c*) for all the six stations :—

Names of the Months, - - - - - -		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Inner Stations, -	0	9	2	11	11	11	5	10	4	6	7	1
	(*b*) the Outer Stations, -	0	5	2	7	13	5	5	15	5	6	5	1
	(*c*) all the Six Stations, -	0	14	4	18	24	16	10	25	9	12	12	2

If these figures be closely examined and compared, it will be found that there is a more or less evident maximum in the total number of records about every three months. This is also found to be the case, though not so distinctly, when the numbers are divided so as to correspond with the inner and outer stations. But taking the total numbers first, it will be observed that, commencing with February, the total number for which is fourteen, there occurs in March a sudden drop, after which the numbers increase till May, when the second highest total for the whole year is reached. In June and July the numbers again fall, to be followed by a marked accession in August, so much so that the maximum for all the twelve months occurs then; in September there is again a marked decrease, after which a slight recovery takes place in October and November, while in December the number is, next to January, the lowest for the year. This increase and decrease, though not so apparent where the numbers are divided to correspond with the inner and outer stations, can still be traced, especially in the series corresponding to the outer stations. The reason for this apparent rhythmical arrangement is not very clear, and it may be that the seemingly periodic recurrence of *Acartia* may be merely accidental.

Formula (3) shows the total number of records of *Acartia* for each year, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) all the six stations :—

Numbers of the Years, - - - - -		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year.	(*a*) the Inner Stations, -	4	10	24	16	14	5	4
	(*b*) the Outer Stations, -	4	13	25	13	5	4	5
	(*c*) all the Six Stations, -	8	23	49	29	19	9	9

It will be observed that the maximum number—that for 1891—is proportionally considerably greater in comparison with the others than is observed either in the case of *Calanus* or *Temora*.

A few of the other species of Copepoda referred to in the lists of townet invertebrates, such as *Pseudocalanus elongatus*, *Centropagus* sp., *Anomalocera patersoni*, and *Oithona* sp., are also at times more or less frequent in the Firth of Forth, but the published records of them show that they are usually less common than those already noticed.

The only points of interest in connection with the distribution of *Pseudocalanus elongatus*, so far as can be made out from the tow-net records of its occurrence, seem to be these—(1st) if an average of all the records of this Copepod for the seven years be taken, the numbers for April and May will be seen to be greater than those for all the other months added together; and (2nd) that the maxima of the records for the seven years occur in 1891, 1892, and 1893.

Anomalocera patersoni, which from its very large size and beautiful colour is easily detected among the tow-net gatherings, is recorded a considerable number of times during the seven years. The greatest total number of records for any of the years is that for 1891, the number for that year being nearly double that for any other of the whole seven, as shown by the formula.

Formula (1) shows the number of records of *Anomalocera* for each of the seven years :—

Numbers of the Years, - - - -	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year,	7	13	17	6	9	4	6

This formula shows a gradual increase to the maximum, then a somewhat irregular decrease.

Formula (2) shows the total number of records of *Anomalocera* for each of the twelve months :—

Names of the Months,	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Number of Records for each Month,	0	0	0	3	20	18	8	7	1	4	0	1

It will be observed that by far the largest number of records for this species occur in May and June; they are much fewer in July, August, and October, and rarely, or none at all, in the other months. It would appear from this that *Anomalocera* is not resident in the estuary, but is only a summer visitor, and, as Formula (1) shows, its visits are fairly regular.

Formula (3) shows the total number of records of *Anomalocera* for each of the six stations :—

	Inner Stations.			Outer Stations.		
Numbers of the Stations, - - - -	I.	III.	IV.	V.	VIII.	IX.
Number of Records for each Station, -	5	5	1	15	16	19

The difference between the inner and the outer stations is very marked here, but is only what might be looked for if *Anomalocera* be only a "visitor" to the estuary and its vicinity. This also explains why Station IV. appears to have been so rarely visited, for, being a migrant, *Anomalocera* is more likely to keep as much as possible to the open water, and avoid inshore localities.

The distribution of the other species mentioned in the lists of tow-net fauna does not call for special analysis; but a few of them are of interest because of their beauty, their rarity, or because of their structural differences and habits.

Metridia hibernica, which is of an elongate form, and has a long and moderately slender abdomen, is recorded only once during the seven years—viz., at Station IX. in May 1892, when a few specimens were obtained. *Metridia* is a comparatively large Copepod.

Candace pectinata is also moderately large, and is readily noticed by its dark chocolate-coloured swimming feet. There are several records of this species in the lists of tow-net invertebrates.

Parapontella brevicornis appears to be only once recorded for the seven years, but the species is not very rare locally.

Dermatomyzon nigripes is also only once mentioned in the tow-net lists for the selected stations.

Monstrilla sp. The most curious of the pelagic Copepods is the *Monstrilla.* Two species—*M. helgolandica* and *M. rigida*—have been captured in the estuary. In swimming it differs from the usual Copepod habit by keeping its antennules straight out in front, instead of holding them at right angles.

Oithona sp. The *Oithona* that is sometimes not uncommon in the Firth of Forth is probably the *O. similis* Claus, as stated by Dr. Giesbrecht.

Caligus rapax is frequently found "free-swimming" in the estuary, and appears to be able to adopt that mode of life at will.

(3.) The Vermes.

THE SAGITTA (*S. bipunctata*).

Leaving the Copepoda, I now pass on to consider the distribution of the *Sagitta.* A glance through the lists of pelagic invertebrates which form part of the trawling records shows that the *Sagitta* forms an item of considerable importance amongst the various objects collected by the tow-nets. Moreover, when the voracity of these curious organisms is taken into account, it is evident that the vast swarms of them that occasionally visit our shores must form a destructive agency of no mean order, and especially if in the vicinity of their swarms fish larvæ happen to be more or less common. It has been clearly proved that *Sagitta* prey to a considerable extent on larval and post-larval fishes—chiefly round fishes. This habit was observed by me several years ago, and before much attention had been given to it otherwise; and it was found that the *Sagitta* not only preyed on the larvæ of round fishes, but they also attacked the smaller Crustacea, and were even observed to devour their own kind—the larger *Sagitta* devouring the smaller.

The distribution of the *Sagitta* in the Firth of Forth during the seven years will be best seen by a reference to the annexed Table.

Table X., showing the Distribution of *Sagitta,* as indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	1	2	–	–	–	1	1	1	–	1	1	–	8
	1890, .	–	2	2	–	2	–	–	–	–	1	1	1	9
	1891, .	1	1	1	2	2	2	1	1	–	1	1	–	13
	1892, .	1	1	1	1	1	–	1	–	1	–	1	2	10
	1893, .	2	2	–	1	–	1	1	1	1	1	2	1	13
	1894, .	1	2	–	1	–	–	–	1	–	–	–	2	7
	1895, .	–	1	–	1	1	–	–	–	1	–	–	2	6
Totals for the Months, . . .		6	11	4	6	6	4	4	4	3	4	6	8	66

TABLE X.—*continued.*

Inner Stations—*continued.*	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
III.	1889, .	1	–	–	–	–	–	–	–	–	–	1	–	2
	1890, .	–	2		1	1	–	1	–	–	1	1	–	9
	1891, .	1	1	–	2	2	1	–	1	–	1	2	–	11
	1892, .	1	2	1	1	1	–	1	–	1	–	1	2	11
	1893, .	2	1	–	–	1	1	1	1	1	1	2	2	13
	1894, .	–	1	–	1	–	–	–	1	–	–	–	4	7
	1895, .	–	1	–	1	–	–	–	–	–	1	–	2	5
Totals for the Months, . . .		5	8	3	6	5	2	3	3	2	4	7	10	58
IV.	1889, .	1	–	–	–	–	–	–	1	–	–	1	–	3
	1890, .	–	2	–	–	1	–	1	–	–	1	2	1	8
	1891, .	2	2	1	–	2	–	–	1	–	1	1	–	10
	1892, .	1	2	2	2	–	–	1	–	1	1	1	1	12
	1893, .	2	2	–	1	–	1	–	–	–	1	1	2	10
	1894, .	1	1	–	1	–	–	–	1	–	–	–	–	4
	1895, .	1	2	–	–	1	–	–	1	–	2	–	2	9
Totals for the Months, . . .		8	11	3	4	4	1	2	4	1	6	6	6	56

Three Outer Stations.	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	2	2	–	–	1	1	–	2	–	–	1	–	9
	1890, .	–	1	–	2	1	–	2	–	–	1	2	2	11
	1891, .	–	–	1	1	1	1	1	1	2	2	2	2	14
	1892, .	1	1	2	1	1	1	1	–	1	1	2	2	14
	1893, .	2	1	–	–	1	1	2	2	1	2	1	2	15
	1894, .	–	2	–	1	–	1	–	1	–	–	–	–	5
	1895, .	–	2	–	1	2	–	–	1	–	–	–	–	6
Totals for the Months, . . .		5	9	3	6	7	5	6	7	4	6	8	8	71

TABLE X.—*continued.*

Outer Stations—*continued.*	Years.	Number of Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
VIII.	1889,	2	–	–	–	–	2	2	1	–	–	1	–	8
	1890,	–	1	1	1	1	–	1	–	1	2	–	1	9
	1891,	–	2	–	2	1	–	1	1	1	2	2	–	12
	1892,	2	2	2	2	2	2	1	–	2	1	–	4	20
	1893,	2	2	–	–	2	1	1	1	1	1	–	2	13
	1894,	1	2	–	1	–	–	–	–	–	–	–	–	4
	1895,	–	2	–	1	2	–	–	1	1	2	–	2	11
Totals for the Months,		7	11	3	7	8	5	6	4	6	8	3	9	77
IX.	1889,	2	–	–	–	–	2	1	1	–	–	1	–	7
	1890,	–	1	2	1	2	–	2	–	2	1	–	2	13
	1891,	–	2	–	2	1	2	1	1	1	2	2	–	14
	1892,	2	1	2	1	1	1	1	–	1	1	–	3	14
	1893,	2	2	–	–	2	1	2	1	–	2	–	2	14
	1894,	–	2	–	–	–	1	–	1	–	–	–	–	4
	1895,	–	2	–	1	–	–	–	2	1	–	–	2	8
Totals for the Months,		6	10	4	5	6	7	7	6	5	6	3	9	74

This Table shows that the total number of records of *Sagitta* for the six selected stations, and for the seven years, is four hundred and five, being somewhat fewer than the number of records of *Calanus*, but considerably in excess of the number of records of any other of the species that have been referred to. In making an analysis of the Table, it is found that while there is a considerable difference between the number of records for Station IV. and that for Station VIII., if the three inner stations and the three outer stations be considered separately, the difference in the numbers of each group is much less. These points will be made more evident by arranging the stations and the number of records for each as a formula, thus :—

Formula (1) shows the number of records of *Sagitta* for each of the six selected stations :—

	The Three Inner Stations.			The Three Outer Stations.		
Numbers of Stations,	I.	III.	IV.	V.	VIII.	IX.
Number of Records for each Station,	66	58	56	74	77	74

The numbers for the three outer stations are nearly equal, but Station I. in the other three shows a greater divergence. It may also be noticed that Station I. and Station VIII., that have the highest number of records in each of the two groups, are intermediate stations—that is, Station I. is situated between Stations III. and IV., and Station VIII. between Stations V. and IX. Moreover, if a comparison be made of the total number of the records for each of the twelve months, it will be observed that those for February and December are considerably greater than the numbers for the other months; but if the numbers are separated into two groups to correspond with the inner and outer stations, the difference in the numbers for each of the twelve months for the three inner stations is increased, while the difference becomes less in the other group of numbers. This is best seen by arranging the numbers as a formula.

Formula (2) shows the total number of records of *Sagitta* for each of the twelve months, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Names of the Months,		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Three Inner Stations,	19	30	10	16	15	7	9	11	6	14	19	24
	(*b*) the Three Outer Stations,	18	30	10	18	21	17	19	17	15	20	17	26
	(*c*) all the Six Stations,	37	60	20	34	36	24	28	28	21	34	36	50

There is one point very clearly brought out in connection with the distribution of the *Sagitta*—viz., that, whether a comparison be made of the monthly numbers of records for each station or for the three inner and three outer stations or for them all, the numbers for February and most of those for December are greater than the others. This would seem to indicate that *Sagitta* was usually more common during these months than at other times of the year.

It will be further observed that the highest total number of yearly records, viz. 79, is that for 1892, and the smallest, 31, for 1894, and that if the yearly records be divided into two sets to correspond with the three inner and the three outer stations, the results, as regards the highest and lowest numbers, are somewhat different. In this arrangement of the figures the highest number for the three inner stations is that for 1893, and the lowest that for 1889, while the maximum and minimum numbers for the outer stations are for the same years as in the former arrangement. Formula (3) will show these results more clearly.

Formula (3) shows the total number of records of *Sagitta* for all the seven years; for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Numbers of the Years,		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for	(*a*) the Inner Stations,	13	26	34	33	36	18	20
	(*b*) the Outer Stations,	24	33	40	48	42	13	25
	(*c*) all the Six Stations,	37	59	74	81	78	31	45

It would thus appear that *Sagitta*, like the majority of the other pelagic organisms of which there are records, are usually of more frequent occurrence in the Firth of Forth and its vicinity during the colder months, and that they were more numerous during 1891, 1892, and 1893 than during the other years. These again coincide with the yearly maxima for *Parathemisto*, and may be the result of a larger migration during these years, as was probably the case with *Parathemisto*, or to circumstances favouring a greater local increase; for though the difference in the number of the yearly records may be partly accounted for by the greater or fewer number of experiments, this does not explain the whole of it. Unfortunately the experiments were not carried on long enough nor so regularly as to indicate whether the difference shown is due to the actual increase or decrease of these organisms, and whether it was temporary and accidental or part of a more or less regular cycle of changes in their migration or development.

(4.) The Cœlenterata.

THE CTENOPHORA AND HYDROMEDUSÆ.

The next groups of organisms that are numerically important and which may be specially noticed are the Ctenophora and Hydromedusæ. These include the well-known and beautiful *Pleurobrachia*, which sometimes occurs in such immense numbers that they seem to monopolise the whole of the water-space where they are. The swarms of these things that are sometimes met in with by the *Garland* are so great that the tow-nets, if unfortunately in use at the time, are found, when hauled on board, to be literally full of these crystal spheres, while little of anything else is found in the nets. The appearance of such a mass of *Pleurobrachia*—each globe, by the rapid movement of its delicate cilia, scintillating in the light—is wonderful, and cannot be accurately described. *Beroë* is another of the Cœlenterates that was sometimes met with in considerable numbers, but not usually in such immense swarms as *Pleurobrachia.* Various other forms, such as *Sarsia, Geryonopsis, Thaumantias,* &c., were also observed during the years referred to, but from want of time no attempt was made to differentiate the species, and they are therefore usually all included under the name of Ctenophora : on a few occasions only are *Pleurobrachiæ* and a few of the others specially mentioned. There are two hundred and ninety-six records of Ctenophora, including Hydromedusæ, among the lists of tow-net gatherings for the seven years, and their distribution for the months and stations is shown by the annexed Table :—

Table XI., showing the Distribution of the Ctenophora and Hydromedusæ, indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Number of the Records for each Month of each Year.												Totals for Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	2	2	–	–	–	1	2	2	–	–	1	–	10
	1890, .	–	–	1	1	–	–	2	2	–	2	1	–	9
	1891, .	1	1	–	–	1	1	–	–	–	2	2	–	8
	1892, .	1	2	1	–	–	2	1	–	–	1	1	2	11
	1893, .	2	1	–	1	1	1	1	2	2	2	1	–	14
	1894, .	–	2	–	–	–	–	–	2	–	–	–	2	6
	1895, .	–	1	–	–	–	–	1	–	–	1	–	1	4
Total number of Records for all the Months,		6	9	2	2	2	5	7	8	2	8	6	5	62
III.	1889, .	1	–	–	–	–	2	2	2	–	–	1	–	8
	1890, .	–	2	–	–	2	–	2	1	–	2	1	–	10
	1891, .	1	–	–	–	–	1	1	1	1	1	2	–	8
	1892, .	1	–	1	1	2	2	1	–	1	1	2	2	14
	1893, .	2	1	–	–	1	1	–	1	2	1	2	1	12
	1894, .	–	1	–	–	–	1	–	2	–	–	–	4	8
	1895, .	–	1	–	–	–	–	2	–	–	1	–	2	6
Total number of Records for all the Months,		5	5	1	1	5	7	8	7	4	6	8	9	66

TABLE XI.—*continued.*

Inner Stations—*continued.*	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
IV.	1889, .	1	–	–	–	–	2	2	2	–	–	1	–	8
	1890, .	–	1	–	1	2	–	–	1	–	2	2	1	10
	1891, .	1	1	–	–	–	1	–	1	–	1	–	–	5
	1892, .	2	1	–	–	–	1	2	–	–	–	1	2	9
	1893, .	2	1	–	–	1	–	–	2	2	2	2	1	13
	1894, .	–	–	–	–	–	–	–	1	–	–	–	–	1
	1895, .	1	–	–	–	–	–	–	2	–	2	–	2	7
Total number of Records for all the Months,		7	4	–	1	3	4	4	9	2	7	6	6	53

Three Outer Stations.	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	1	1	–	–	–	1	2	1	–	–	1	–	7
	1890, .	–	1	–	–	1	–	2	–	–	2	1	–	7
	1891, .	–	1	–	–	–	–	1	–	1	2	1	–	6
	1892, .	1	1	1	–	1	2	1	–	2	–	2	1	12
	1893, .	1	–	–	–	2	–	–	2	1	1	–	1	8
	1894, .	–	1	–	–	–	1	–	1	–	–	–	–	3
	1895, .	–	1	–	–	–	–	–	–	–	–	–	–	1
Total number of Records for all the Months,		3	6	1	–	4	4	6	4	4	5	5	2	44
VIII.	1889, .	1	–	–	–	–	–	2	2	–	–	1	–	6
	1890, .	–	–	–	–	1	–	–	1	–	–	–	–	2
	1891, .	–	–	–	–	–	–	–	–	–	2	–	–	2
	1892, .	1	–	1	–	–	2	1	–	2	1	–	2	10
	1893, .	1	1	–	–	1	1	1	1	1	–	–	–	7
	1894, .	–	1	–	–	–	2	–	–	–	–	–	–	3
	1895, .	–	–	–	–	1	–	–	1	–	1	–	1	4
Total number of Records for all the Months,		3	2	1	–	3	5	4	5	3	4	1	3	34

TABLE XI.—*continued.*

Outer Stations—*continued.*	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
IX.	1889, .	1	–	–	–	–	–	2	1	–	–	1	–	5
	1890, .	–	–	–	–	1	–	–	1	2	–	–	–	4
	1891, .	–	–	–	1	–	2	–	–	1	2	1	–	7
	1892, .	–	–	–	–	1	2	2	–	–	2	–	3	10
	1893, .	1	1	–	–	–	1	1	–	–	1	–	1	6
	1894, .	–	–	–	–	–	2	–	–	–	–	–	–	2
	1895, .	–	1	–	–	–	–	–	1	–	–	–	1	3
Total number of Records for all the Months,		2	2	–	1	2	7	5	3	3	5	2	5	37

In 1889 small Cœlenterates were abundant in a bottom tow-net gathering collected at Station IV. in July. In 1890 they were abundant in a surface tow-net gathering at the same station in May. In 1891 they were abundant in a bottom tow-net gathering collected at Station I. in July, and at Station IX. in June; and they were also abundant in a surface tow-net gathering at Station IX. in October. Cœlenterates were frequently obtained in 1892, but in none of the records for the selected stations are they described as abundant. In 1893 they were abundant in a bottom tow-net gathering at Station I. in August, and also at Station IV. in the same month, but at the latter station they were abundant in the surface as well as in the bottom tow-net; in the same year they were also abundant in a surface tow-net gathering at Station V. in May. In 1894 Cœlenterata were abundant in bottom tow-net gatherings collected in June at Stations III. and IV., while in August 1895 they were abundant in a surface gathering at Station III., and in a bottom gathering at Station IV.

From an examination of the annexed Table showing the general distribution of Ctenophora and Hydromedusæ, it will be observed that there is a somewhat curious contrast between their distribution and that of *Sagitta.* On comparing the total number of the records of Cœlenterata and *Sagitta* for each of the three inner and outer stations, it is found that while in the case of *Sagitta* the larger numbers are those of the outer stations, it is just the reverse with the Cœlenterates, the largest numbers being those of the inner stations. This contrast is better seen by arranging the numbers of the records of *Sagitta* and Ctenophora for each of the stations, in juxtaposition as a formula, thus :—

Formula (1) shows the total number of records of Cœlenterata for all the six stations, to which the numbers of the records of *Sagitta* are added for comparison :—

	Inner Stations.			Outer Stations.		
Numbers of the Stations, - - - - -	I.	III.	IV.	V.	VIII.	IX.
Number of Records for each Station (Cœlenterata)	62	66	53	44	34	37
Number of Records for each Station (*Sagitta*) -	66	58	56	74	77	74

It would thus appear that while *Sagitta* was comparatively scarce at the inner stations, Cœlenterata were more numerous. This difference does not seem to be merely accidental; it is too general and persistent for that being the case, and is possibly due rather to a difference in the habits of the two kinds of organisms, but the reason, whatever it is, does not appear to be very obvious. An examination of the total numbers of the monthly records of Cœlenterata for each station, as well as for all the six stations, shows one or two other points of difference between the distribution of these organisms and that of *Sagitta*. In the case of these Cœlenterates the lowest numbers of records for any of the six stations are those for March and April, whereas, in the case of *Sagitta*, the lowest numbers are, with one exception, those for June and July. It will be further observed that, if the numbers of the monthly records are separated to correspond with the inner and the outer stations, ten of the monthly numbers for the inner stations are greater, and some of them considerably greater, than the corresponding numbers for the outer stations, while one of the other two numbers is equal to, and the second only slightly less than, the numbers for the same months for the outer stations, which emphasises still further the difference in the distribution of these Cœlenterates between the inner and outer stations. This is more clearly shown by the Formula (2).

Formula (2) shows the total number of records of Ctenophora and Hydromedusæ for each of the twelve months, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Names of the Months,		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Inner Stations,	18	18	3	4	10	16	19	24	8	21	20	20
	(*b*) the Outer Stations,	8	10	2	1	9	16	15	12	10	14	8	10
	(*c*) all the Six Stations,	26	28	5	5	19	32	34	36	18	35	28	30

That Cœlenterates were more numerous at the inner than at the outer stations is still further shown by separating the yearly total numbers so as to correspond with the two groups of stations as in Formula (3).

Formula (3) shows the total number of records of Ctenophora and Hydromedusæ for each of the seven years, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Numbers of the Years,		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for	(*a*) the Inner Stations,	26	29	21	34	39	15	17
	(*b*) the Outer Stations,	18	13	15	32	21	8	8
	(*c*) all the Six Stations,	44	42	36	66	60	23	25

This formula shows that the number of yearly records for the outer stations is considerably lower for every year except 1892, when the respective numbers more nearly approximate. The highest number for the inner stations is that for 1893, and for the outer stations the highest number is that for 1892, while the lowest numbers for both are in 1894 and 1895.

(5.) LARVAL AND YOUNG CRUSTACEA.

The next group of organisms described in the tow-net records which are of numerical importance are the young of various species of Crustacea belonging to the Decapoda, Schizopoda, and Cirripedia. Young and larval Crustacea are generally more or less frequent during the summer months, and sometimes they occur in great abundance, and because of this, and also because of their nutritive qualities, they form one of the most important constituents of fish-food existing in the sea; this remark applies, of course, to young Entomostracans as well as to the other orders of this great class of invertebrata. The minute nauplei, the larger megalops, and other stages of crustacean growth, along with embryo mollusca, form, no doubt, the principal food of young fishes of all kinds. Mr H. Dannevig, in his paper* describing his experiments in the rearing of larval and post-larval plaice and other flat fishes, gives some interesting observations bearing on the value of young Crustacea as fish food. The examination of the stomach of large numbers of young fishes at the Marine Laboratory of the Fishery Board for Scotland at Tarbert, Loch Fyne, during 1886-87, some of the results of which are published in the Board's Fifth Annual Report, also show that the importance of young Crustacea as fish food has long been recognised, and, as a matter of fact, their importance in this respect cannot well be overstated. It is evident, therefore, that the study of the distribution of these miniature forms, and of the influences that govern their increase or decrease, as well as the investigation of their life-histories and development, are well within the scope of scientific fishery work.

The records of miniature Crustacea included in the lists of tow-net fauna that form the basis of this paper refer chiefly to the young of various species of the Decapoda. Among the more common of the larval Decapoda included in the tow-net gatherings are those of *Portunus* (or swimming crabs), of *Porcellana longicornis*, of the Eupaguridæ (or soldier or hermit crabs), and of *Nephrops norvegicus* (the "Norway lobster"). The young of *Galathea* (or what some fishermen call the "bastard lobster") and of various shrimps, such as *Crangon* and *Pandalus*, which are at times more or less frequent, are also included among these records under the general name of young or larval Crustacea. Young Schizopoda, as such, are specially referred to in the lists only when they happen to be common or abundant; at other times they are included with the young Decapods. The larvæ and young of the Barnacle are more frequently recorded separately, but they also are sometimes included with the others, and the table of distribution comprises the records of all the three groups. The total number of records referring to young and larval Crustacea is about three hundred and forty, and an enumeration of them is contained in the annexed Table. This Table shows that in some respects the distribution of the immature Crustacea is somewhat similar to that of the Cœlenterata. If, for example, the total number of records of immature Crustacea for each of the three inner stations be compared with those for the three outer stations, they will be found on an average larger than the others, though this difference is not so marked as is the case with Cœlenterata.

It will also be observed that the yearly maxima of records for the various stations are not so regular, and also that the larger of the monthly records occur during the summer months.

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* Fifteenth Annual Report of Fishery Board for Scotland. Part iii. Pp. 175-193.

[Table.

TABLE XII., showing the Distribution of the Larval Crustacea (including Decapoda, Schizopoda, and Cirripedia), as indicated by the Townet Records for the Years, Months, and Stations :—

Three Inner Stations.	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	–	–	–	–	–	1	2	2	–	2	–	–	7
	1890, .	–	1	2	2	1	–	2	2	–	2	2	–	14
	1891, .	–	–	1	2	2	2	1	2	–	2	1	–	13
	1892, .	–	–	–	2	2	1	2	–	2	1	2	–	12
	1893, .	–	–	–	2	2	1	2	2	2	2	–	–	13
	1894, .	–	–	–	1	–	–	–	2	–	–	–	–	3
	1895, .	–	–	–	2	1	–	1	–	2	2	–	–	8
Total number of Records for all the Months,		–	1	3	11	8	5	10	10	6	11	5	–	70
III.	1889, .	–	–	–	–	–	1	2	2	–	–	1	–	6
	1890, .	–	–	–	2	–	–	2	2	–	2	1	–	9
	1891, .	–	–	–	–	3	–	1	2	1	2	2	–	11
	1892, .	–	–	–	2	1	1	2	–	2	1	–	–	9
	1893, .	–	–	–	–	2	2	2	2	2	1	1	–	12
	1894, .	–	–	–	2	–	1	–	–	–	–	–	1	4
	1895, .	–	–	–	2	1	–	–	2	1	2	–	1	9
Total number of Records for all the Months,		–	–	–	8	7	5	9	10	6	8	5	2	60
IV.	1889, .	–	–	–	–	–	1	2	2	–	–	1	–	6
	1890, .	–	–	–	1	1	–	2	2	–	2	1	–	9
	1891, .	–	–	–	2	1	1	2	2	–	–	1	–	9
	1892, .	–	–	1	2	2	–	2	–	2	2	1	–	12
	1893, .	–	–	–	2	1	1	–	1	2	1	–	–	8
	1894, .	–	–	–	2	–	1	–	1	–	–	–	–	4
	1895, .	–	–	–	1	2	–	–	2	–	2	–	–	7
Total number of Records for all the Months,		–	–	1	10	7	4	8	10	4	7	4	–	55

[TABLE.

TABLE XII.—*continued.*

Three Outer Stations.	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	–	–	–	–	1	1	–	3	–	–	1	–	6
	1890, .	–	–	–	1	1	–	2	–	2	2	1		10
	1891, .	–	–	1	1	2	–	1	2	1	1	1	–	10
	1892, .	–	–	–	2	1	1	1	–	2	–	2	–	9
	1893, .	–	–	–	–	2	2	1	2	2	1	1	–	11
	1894, .	–	–	–	2	–	–	–	1	–	–	–	–	3
	1895, .	–	–	–	2	1	–	–	2	2	–	–	–	7
Total number of Records for all the Months,		–	–	1	8	8	4	5	10	9	4	6	1	56
VIII.	1889, .	–	–	–	–	–	1	1	2	–	–	1	–	5
	1890, -	–	–	–	1	2	–	–	2	2	2	–	1	10
	1891, -	–	–	–	2	1	2	2	2	2	1	1	–	13
	1892, .	–	–	–	–	2	–	–	–	2	–	–	–	4
	1893, .	–	–	–	–	1	–	2	1	1	–	–	1	6
	1894, .	–	–	–	2	–	–	–	1	–	–	–	–	3
	1895, .	–	–	–	1	1	–	–	2	2	2	–	–	8
Total number of Records for all the Months,-		–	–	–	6	7	3	5	10	9	5	2	2	49
IX.	1889, .	–	–	–	–	–	1	2	2	–	–	1	–	6
	1890, .	–	–	–	1	1	–	–	2	1	2	–	1	8
	1891, .	–	–	–	1	1	1	2	1	2	–	–	–	8
	1892, .	–	–	1	–	3	–	1	–	2	1	1	–	9
	1893, .	–	–	–	1	2	2	2	1	–	1	–	–	9
	1894, .	–	–	–	1	–	1	–	1	–	–	–	–	3
	1895, .	–	–	–	2	1	–	–	2	2	–	–	–	7
Total number of Records for all the Months,		–	–	1	6	8	5	7	9	7	4	2	1	50

There is one aspect of the question of the distribution of these young Crustaceans, as well as of that of the various other invertebrates touched upon in this paper, that it is well to keep in view in an inquiry of this kind. I refer to the individual frequency or abundance of these organisms at one time, or at different times, apart from the frequency or rarity of their recorded occurrences. In the Table showing the distribution of the young Crustacea the maximum numbers of the yearly records are, speaking generally, those for 1891, 1892, and 1893; while, on the other hand, if the individual frequency of the creatures be taken into account, the results brought out will be somewhat different. For example, young Crustacea are described as abundant in four of the records for 1890

—viz., twice for Station I. in July, and once for Stations V. and VIII. in September. They are described as abundant in four of the records for 1891—viz., once for Station VIII. in May, once for Stations III. and IX. in July, and once for Station I. in August. They are recorded as abundant three times in 1892—once for each of the three Stations V., VIII., and IX. in September. Young Crustacea are described as abundant five times in 1893, once for Station I. and twice for Station III. in July, and also twice for Station V. in June. In 1894 there are over twenty records of young Crustacea, but in none are they described as abundant unless the three April records of young *Balani* (for Stations I., III., and IV.) be counted. On the contrary, in 1895 young Crustacea are described as abundant no fewer than twelve times, once at each of the three outer stations (V., VIII., and IX.) in April, once at Stations III. and V. in August, once at Stations I., III., and VIII. in September, and once at Stations I., III., and IV. in October—thus indicating that, notwithstanding the difference in the number of records when compared with those for 1891, 1892, or 1893, young Crustacea were locally more plentiful in the estuary and its vicinity in 1895 than during the other three years referred to.

The number of separate records of young Schizopoda is thirty-two for the seven years, and their distribution is indicated by the following three formulæ :—

Formula (1) shows the total number of records of Schizopoda for each of the stations :—

Number of the Stations, - - - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station, - -	12	4	0	3	7	6

Formula (2) shows the total number of records of Schizopoda for each of the twelve months :—

Names of the Months, - - - - -	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, - -	0	0	2	6	4	3	2	4	4	5	1	1

Formula (3) shows the total number of records of Schizopoda for each of the seven years :—

Numbers of the Years, - - - -	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, -	5	16	6	1	4	0	0

The separate records of young *Balani* number fifty-eight. These larval Crustaceans are described as abundant in 1891 at Station I. in April, and in 1892 at Station III. in April. In 1893 they appear to have been plentiful at the inner stations, and are described as abundant in a surface tow-net gathering at Station I. in April, in the bottom tow-net at Station III. in June, and in a surface tow-net gathering at Station IV. in April. In 1894 young *Balani* are described as abundant in the bottom tow-net gatherings collected at Stations I., III., and IV. in April. In all the other records of these immature Crustaceans they are either described as common or few. Their distribution is indicated by the following three formulæ :—

Formula (1) shows the total number of records of young *Balani* for each of the six stations :—

Numbers of the Stations, - - - - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station, - -	12	12	17	3	8	6

This formula shows that young *Balani* were, as might be expected, more numerous at the three inner stations, and that the highest number of records of these three stations is that for Station IV. This difference in the numbers of the records of these young forms is satisfactorily explained by the fact that the greater number of the Barnacle tribe, in our seas at least, are to be found attached to rocks, stones, and other objects inshore, and that there the young are usually to be found.

Formula (2) shows the total number of records of young *Balani* for each of the twelve months for all of the six stations:—

Names of the Months,	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month,	0	0	1	27	14	10	4	2	0	0	0	0

It is evident from the numbers in this formula that the *Balani* hatch out principally in April, and that after April there is a rapid diminution in the production of larval forms, after which a more or less complete cessation takes place, there being not a single record for all the six months from September to February.

Formula (3) shows the total number of records of young *Balani* for each of the seven years for all the six stations:—

Numbers of the Years,	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year,	4	9	20	7	11	5	2

The number of records for 1891 is greatly in excess of that for any of the other seven years, but the reason for this marked difference does not seem to be very clear.

But the records of young Schizopoda and *Balani* form a comparatively small part of the whole number. The largest proportion of the three hundred and forty records of young and larval Crustacea are those of various species of Decapods, as has already been stated. But resuming consideration of the young Crustacea, we find by an examination of the general Table of Distribution that with one exception there are no records for January and February in all the seven years and for all the stations. After this a sudden increase is observed over all the stations, so much so that in regard to two of the stations the maximum of records is reached in April. From this time the number decreases somewhat till August, when a marked extension occurs over all the stations, the number afterward gradually diminishing till November. In December there is a somewhat sudden drop to one or two records, or, in the case of two of the stations, to none at all. This sudden increase and subsequent continuance of the moderately high numbers of the monthly records till November is an indication that in March and April an extensive and more or less simultaneous hatching of Crustacean ova takes place, and that it continues more or less all through the summer and autumn and on till about the end of the year. Of course it is not suggested that it is the same species that produces these young forms all the year through, but that the ova of different species hatch out at different seasons and thus keep up the supply of larval and young forms. The subjoined formulæ, prepared from the numbers in the Table of Distribution, show more clearly by the arrangement of the numbers in this way some of the special features referred to in the distribution of the young and larval Crustacea.

Formula (1) shows the total number of the records of young Crustacea for each of the six stations, which are divided into inner and outer stations:—

	Inner Stations.			Outer Stations.		
Number of the Stations,	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station,	70	60	55	56	49	50

This formula shows that Station I. has a higher number of records than any others, and that the total number of records for the three outer stations is 155, while the total number for the three inner stations is 185, or fully 16 per cent. more than the outer.

Formula (2) shows the total number of records of young Crustacea for each of the twelve months, for (*a*) the three inner stations, I., III., and IV.; (*b*) the three outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Names of the Months, - - - - - -		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total number of Records for each Month, for	(*a*) the Inner Stations, - -	0	1	4	29	22	14	27	30	16	26	14	2
	(*b*) the Outer Stations, - -	0	0	2	20	23	12	17	29	25	13	10	4
	(*c*) all the Six Stations. -	0	1	6	49	45	26	44	59	41	39	24	6

Formula (3) shows the total number of the records of young Crustacea for each of the seven years, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations:—

Numbers of the Years, - - - - - -		1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for	(*a*) the Inner Stations,	19	32	33	33	33	11	24
	(*b*) the Outer Stations,	17	28	31	22	26	9	22
	(*c*) all the Six Stations,	36	60	64	55	59	20	46

But besides young and larval Crustacea there are other immature forms mentioned in the lists of tow-net gatherings, and among them are occasional records of embryo and young Mollusca (including Gasteropoda, Lamellibranchiata, and Cephalopoda), young and larval Annelides, as well as plutei and other immature stages of star-fishes.

Infusoria and microscopic algæ are also described as being occasionally in greater or less abundance, but the records of these forms are few in number.

There are occasional records of larval and post-larval fishes among the lists of tow-net gatherings, but they also are comparatively few.

(6.) PELAGIC FISH OVA.

There are a considerable number of records of pelagic fish ova among the published lists of tow-net gatherings collected during the seven years. These records, which for the sake of clearness are arranged in tabular form similar to the other Tables, show that the total numbers for the inner and outer stations are in inverse ratio to the records of young Crustacea for the same stations, and this difference may probably be accounted for by the outer stations being nearer to the more important spawning grounds situated in the vicinity of the estuary.

TABLE XIII., showing the Distribution of Fish Ova, as indicated by the Tow-net Records for the Years, Months, and Stations.

Three Inner Stations.	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
I.	1889, .	–	–	–	–	–	1	–	–	–	–	–	–	1
	1890, .	–	–	–	1	1	–	–	–	–	–	–	–	2
	1891, .	–	–	–	1	2	1	–	1	–	–	–	–	5
	1892, .	–	–	–	1	1	1	1	–	–	–	–	–	4
	1893, .	–	–	–	1	1	1	–	–	–	–	–	–	3
	1894, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1895, .	–	–	–	–	1	–	–	–	–	–	–	–	1
Total number of Records for all the Months,		–	–	–	5	6	4	1	1	–	–	–	–	17
III.	1889, .	–	–	–	–	–	–	–	–	–	–	–	–	–
	1890, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1891, .	–	–	–	–	1	1	1	1	–	–	–	–	4
	1892, .	–	–	–	1	–	1	–	–	–	–	–	–	2
	1893, .	–	–	–	–	1	–	–	–	–	–	–	–	1
	1894, .	–	–	–	2	–	–	–	–	–	–	–	–	2
	1895, .	–	–	–	–	1	–	–	–	–	–	–	–	1
Total number of Records for all the Months,		–	–	–	4	3	2	1	1	–	–	–	–	11
IV.	1889, .	–	–	–	–	–	1	–	–	–	–	–	–	1
	1890, .	–	–	–	1	2	–	–	–	–	1	–	–	4
	1891, .	–	–	–	–	2	1	1	1	–	–	–	–	5
	1892, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1893, .	–	–	–	–	1	–	–	–	–	–	–	–	1
	1894, .	–	–	–	1	–	–	–	–	–	–	–	–	1
	1895, .	–	–	–	–	1	–	–	–	–	–	–	–	1
Total number of Records for all the Months,		–	–	–	3	6	2	1	1	–	1	–	–	14

TABLE XIII.—*continued.*

Three Outer Stations.	Years.	Number of the Records for each Month of each Year.												Totals for the Years and Stations.
		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
V.	1889, .	–	–	–	–	1	–	–	–	–	–	–	–	1
	1890, .	–	–	1	1	1	–	–	–	–	–	–	–	3
	1891, .	–	–	1	1	1	1	1	1	–	–	–	–	6
	1892, .	–	–	1	–	2	1	1	–	–	–	–	–	5
	1893, .	–	–	–	–	1	–	–	1	–	–	–	–	2
	1894, .	–	1	–	1	–	–	–	–	–	–	–	–	2
	1895, .	–	–	–	1	1	–	–	1	–	–	–	–	3
Total number of Records for all the Months,		–	1	3	4	7	2	2	3	–	–	–	–	22
VIII.	1889, .	–	–	–	–	–	1	–	–	–	–	–	–	1
	1890, .	–	–	1	1	1	–	–	–	–	–	–	–	3
	1891, .	–	1	–	1	1	–	1	–	–	–	–	–	4
	1892, .	–	–	1	–	3	1	1	–	–	–	–	–	6
	1893, .	–	–	–	–	1	–	–	1	–	–	–	–	2
	1894, .	–	1	–	1	–	–	–	–	–	–	–	–	2
	1895, .	–	1	–	1	1	–	–	–	–	–	–	–	3
Total number of Records for all the Months,		–	3	2	4	7	2	2	1	–	–	–	–	21
IX.	1889, .	–	–	–	–	–	–	1	–	–	–	–	–	1
	1890, .	–	–	–	1	–	–	–	–	–	1	–	–	2
	1891, .	–	1	–	1	1	1	1	1	–	–	–	–	6
	1892, .	1	–	1	–	2	1	1	–	–	–	–	1	7
	1893, .	1	–	–	1	–	2	–	–	–	–	–	–	4
	1894, .	–	1	–	1	–	–	–	1	–	–	–	–	3
	1895, .	–	–	–	1	1	–	–	1	–	–	–	–	3
Total number of Records for all the Months,		2	2	1	5	4	4	3	3	–	1	–	1	26

It will be seen by a glance at the annexed Table that while the number of records of fish ova for Stations I., III., and IV. are 16, 11, and 14 respectively, those for the outer stations, V., VIII., and IX., are 22, 21, and 26. Moreover, it may be stated in connection with this difference between the inner and outer stations, and as tending to emphasise it, that the inner stations were examined a greater number of times than the outer stations, owing to the outer stations being more exposed, and therefore less easily examined during bad weather.

Formula (1) shows the number of records of pelagic fish ova for each of the six stations, thus :—

	(*a*) Inner Stations.			(*b*) Outer Stations.		
Numbers of the Stations, - - -	I.	III.	IV.	V.	VIII.	IX.
Total number of Records for each Station,	16	11	14	22	21	26

This formula exhibits a marked difference between the number of records for the inner and outer stations, those for the outer stations being considerably larger. The total numbers for each of the two groups of stations are 41 and 69 respectively, showing a difference of 28 in favour of the outer stations, which is equal to nearly 41 per cent.—a difference which, as already stated, is doubtless owing to the outer stations being nearer the more important spawning-grounds.

Formula (2) shows the total number of records of pelagic fish ova for each of the twelve months, for (*a*) the inner stations, I., III., and IV.; (*b*) the outer stations, V., VIII., and IX.; and (*c*) for all the six stations :—

Names of the Months, - - - - - -	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
Total number of Records for each Month, for (*a*) the Inner Stations, -	0	0	0	11	14	9	3	3	0	1	0	0
(*b*) the Outer Stations, -	2	6	6	13	18	8	7	7	0	1	0	1
(*c*) all the Six Stations, -	2	6	6	24	32	17	10	10	0	2	0	1

The monthly maxima of the records of pelagic fish ova, as might be expected, are to be found in the early spring and summer months, those for April and May especially being considerably higher than for the other months. The arrangement of the numbers to correspond with the inner and outer stations brings out another contrast between them : for the inner stations there are no records of fish ova till April, nor are there any after October, but for the outer stations there are two records in January, six in February and in March, and one in December ; while with the exception of June the numbers for the five central months are considerably above those of the corresponding months for the inner stations. This seems to indicate that spawning outside begins at a comparatively early period of the year, and may continue more or less over all the months : inside the estuary, on the other hand, spawning is later in commencing, and rarely continues beyond the month of August. It is probable that some of the ova collected at the inner stations may have drifted in or been carried in by currents from the outside, but it is also well known that there are a number of fishes, whose eggs float, that spawn within the estuary, so that the majority of the records for the inner stations are those of fishes that have really spawned there.

The next *Formula* (3) shows the total number of records of pelagic fish ova for each of the seven years for (*a*) the inner stations, (*b*) the outer stations, and (*c*) for all the six stations :—

	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Total number of Records for each Year, for (*a*) the Inner Stations, -	2	7	14	7	5	4	3
(*b*) the Outer Stations, -	3	8	16	18	8	7	9
(*c*) all the Six Stations, -	5	15	30	25	13	11	12

The largest number of records are those for 1891 and 1892. Another point in connection with the distribution of the pelagic fish ova, as shown by the published tow-net records, is the occurrence of them in several of the bottom tow-net gatherings. The records show that pelagic fish ova were found in bottom tow-net gatherings on eight different occasions, and it is noteworthy that on a few of these occasions no fish eggs were observed in the surface tow-net. This feature in the distribution of the pelagic fish ova cannot be shown in the Table, but is clearly indicated in the chart showing the comparative frequency of fish ova during the various months and years for all the stations. Pelagic fish ova were found in the bottom tow-net in 1889 at Station IV. in June; in 1890 at Station IV. in April and May, and at Station V. in May; in 1891 at Station I. in May, and in the same month at Station IV.; in 1892 at Station VIII. in May; and in 1894 at Station III. in April. In the records for all the seven years pelagic fish ova are three times described as abundant, and this only in 1894, when they are so described once for each of the three outer stations.

(7.) EXPLANATION OF THE CHARTS (PLATES IV. TO VII.).

Before concluding this paper on the tow-net gatherings collected in the Firth of Forth in connection with the trawling investigations of the Fishery steamer *Garland* during the years 1889 to 1895, and published in the Annual Reports for these years, I desire to say a few words about the charts appended hereto, by way of explaining their contents. These charts are intended to supplement what has already been said concerning the distribution of a few of the organisms that are numerically or otherwise of greater importance than the others in their relation to fishery questions. The charts exhibit certain important features respecting the distribution of these organisms that could not be readily shown in the Tables, by indicating concisely and graphically the relative scarcity or abundance of these organisms as well as their distribution vertically and horizontally. The years and months are arranged in regular sequence along the top of each chart. Where the organisms are present in the tow-net gatherings they are indicated under four degrees of frequency, viz.:—(1) as abundant, represented by the contraction "ab."; (2) as common, represented by "com."; (3) as frequent, represented by "fr."; and (4) as few or rare, represented by "f. or r."; if the organisms are altogether absent or are not referred to in the tow-net lists, this fact is indicated by the word "none," which is the last in the series. These abbreviations are used for each of the six stations, and are arranged alongside of them. The tow-net records for each month are represented by round dots; the dots are arranged to show whether the species referred to on the chart was abundant, common, frequent, few or rare, or absent in the gathering represented. Moreover, these dots are joined together by thick or thin lines: the thick lines show that the records are for bottom tow-net gatherings, and the thin lines for surface tow-net gatherings. When the distribution of two organisms or groups of organisms are represented separately on the same chart, they are distinguished from each other by using black and red lines. There is one other point in connection with the charts that requires to be explained. It has been stated that, for various reasons, the selected stations were not examined every month during the seven years, and that there are now and again omissions of the monthly records of tow-net fauna, either because no trawling was done, or if done that the usual lists of the contents of the tow-nets could not be prepared. The months when such omissions occurred are indicated on the charts by the thick and thin lines when crossing the column or columns under these months being discontinuous.

The first chart (Plate IV.) illustrates the distribution of *Calanus finmarchicus* and *Temora longicornis*. The first is shown by the black lines, the other by the red lines.

The second chart (Plate V.) illustrates the distribution of *Sagitta bipunctata* and the Cœlenterata. *Sagitta* is represented by the black lines, and the Cœlenterata by the red lines.

The third chart (Plate VI.) illustrates the distribution of the larval and young Decapod Crustacea (including the Schizopoda) and that of the larval and young *Balani*. The *Balani* are represented by the red lines, the others by the black lines.

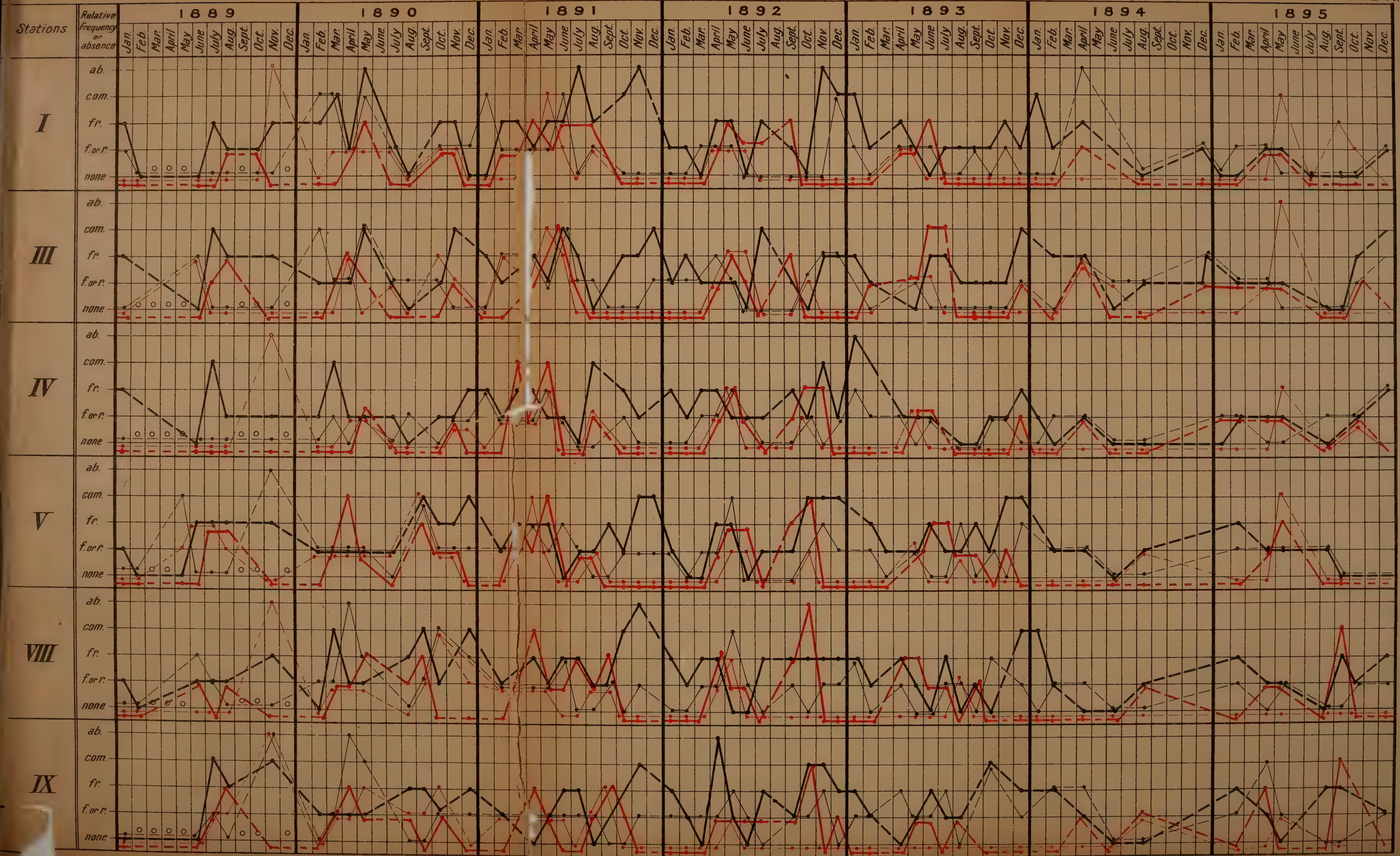
The fourth chart (Plate VII.) shows the distribution of the pelagic fish ova so far as that is indicated by a study of the tow-net records for the seven years.

The following list contains the names of all the species of Mollusca and Crustacea referred to in the preceding notes, and of *Sagitta* and *Tomopteris*, and the stations where each was obtained:—

CHART showing the distribution and relative abundance of *Calanus finmarchicus* and *Temora longicornis* in the Firth of Forth.

Black Lines = *Calanus*; Red Lines = *Temora*. Thick Lines = Bottom tow net; Thin Lines = Surface tow net.

PLATE IV.



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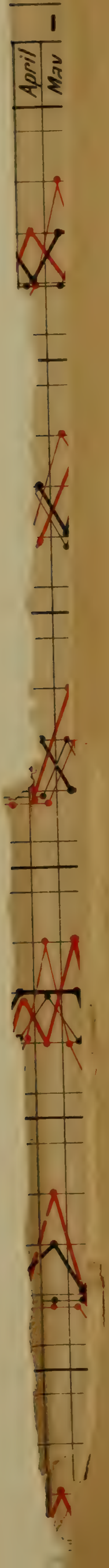

PLATE V.

CHART showing the distribution and relative frequency of *Sagitta* and *Ctenophora*, (including the *Hydromedusæ*,) in the Firth of Forth, as indicated by the records of these organisms in the Lists of tow net gatherings referred to in the preceding notes.

Black Lines = *Sagitta*; Red Lines = *Ctenophora*. Thick Lines = Bottom tow net; Thin Lines = Surface tow net.

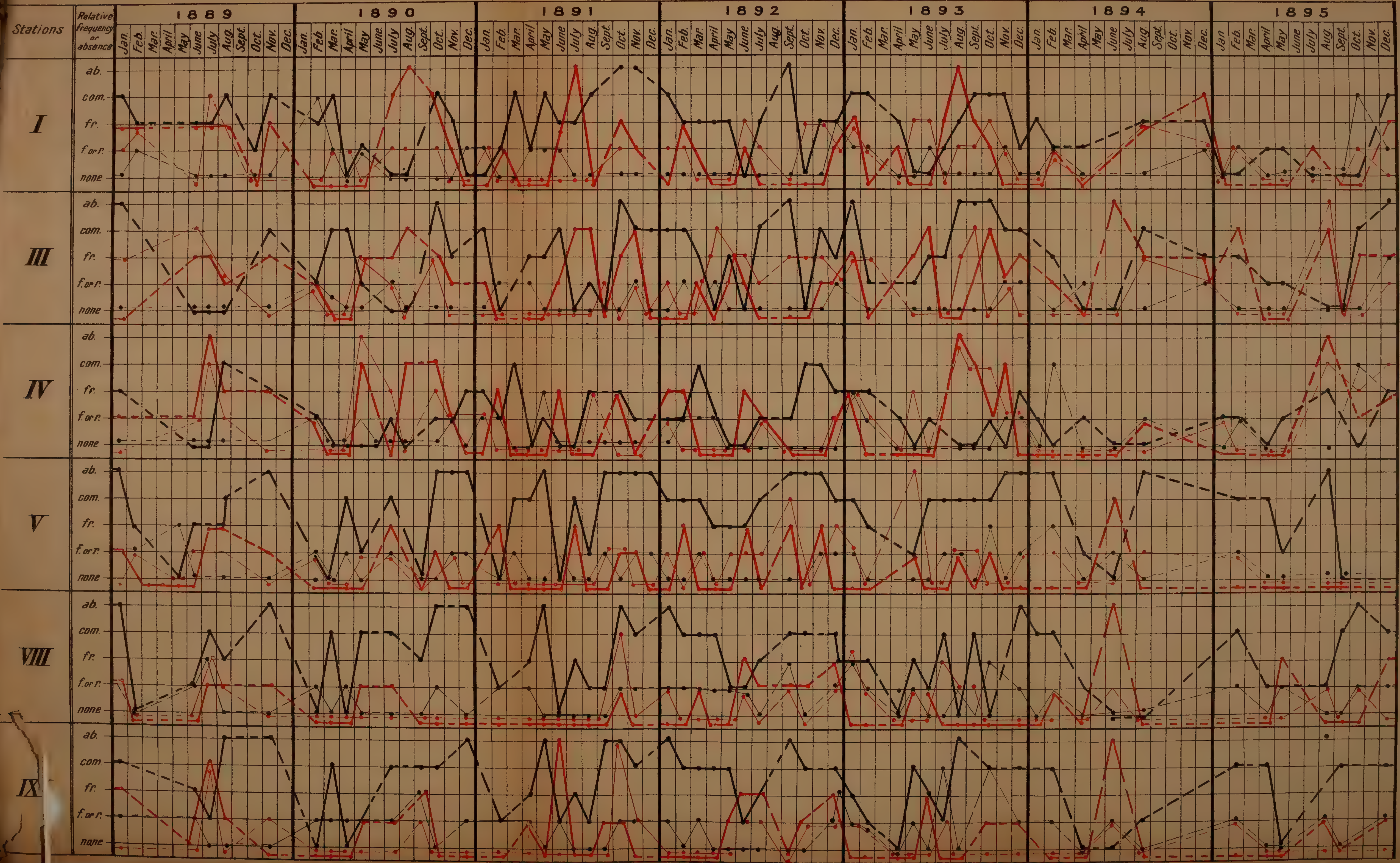

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CHART showing the distribution and relative frequency of Larval and young Crustacea in the Firth of Forth, as indicated by the records of these organisms in the Lists of tow net gatherings referred to in the preceding notes.

Black Lines = Young Decapod Crustacea (chiefly); Red Lines = Young *Balani*. Thick Lines = Bottom tow net; Thin Lines = Surface tow net.

PLATE VI.

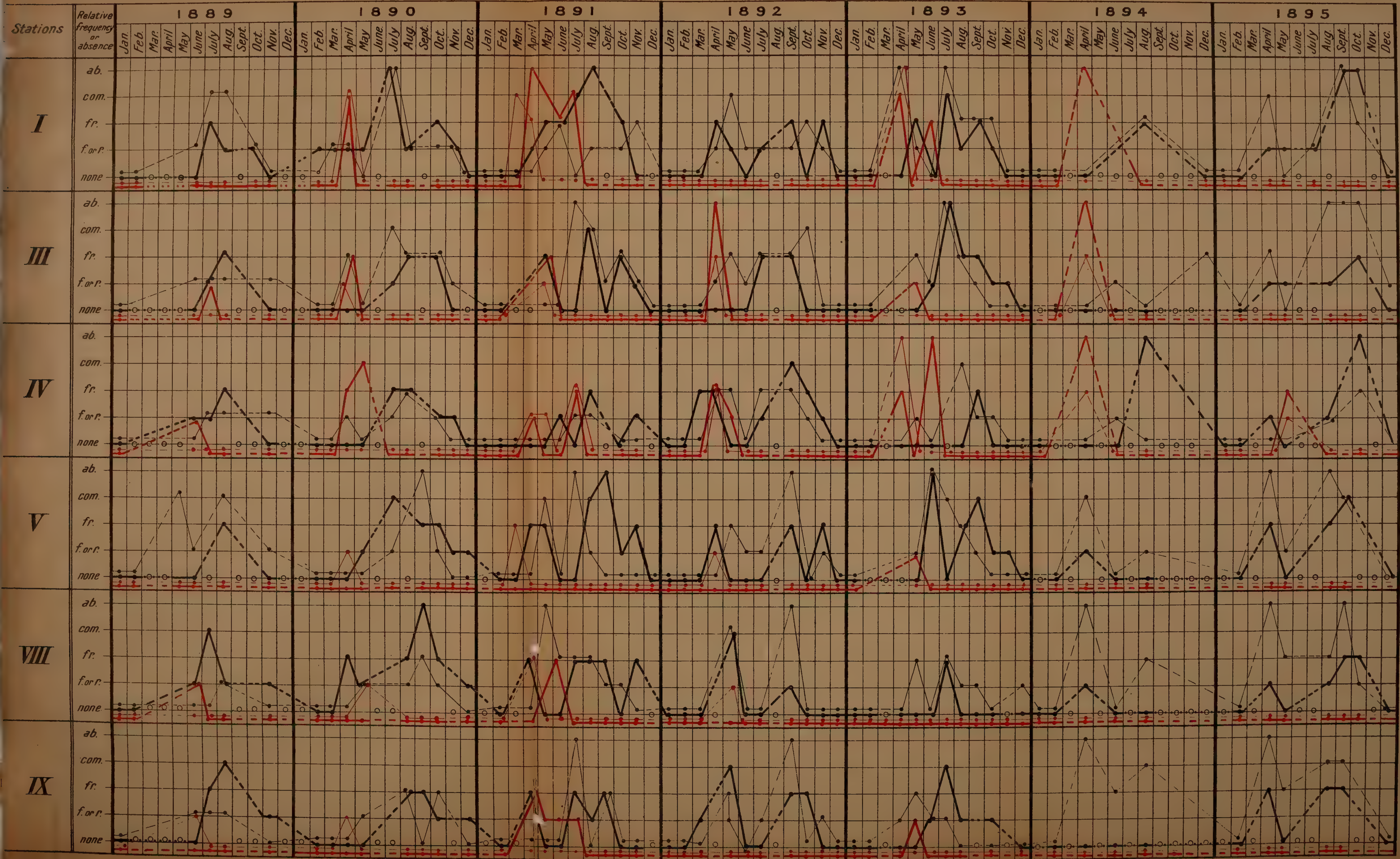
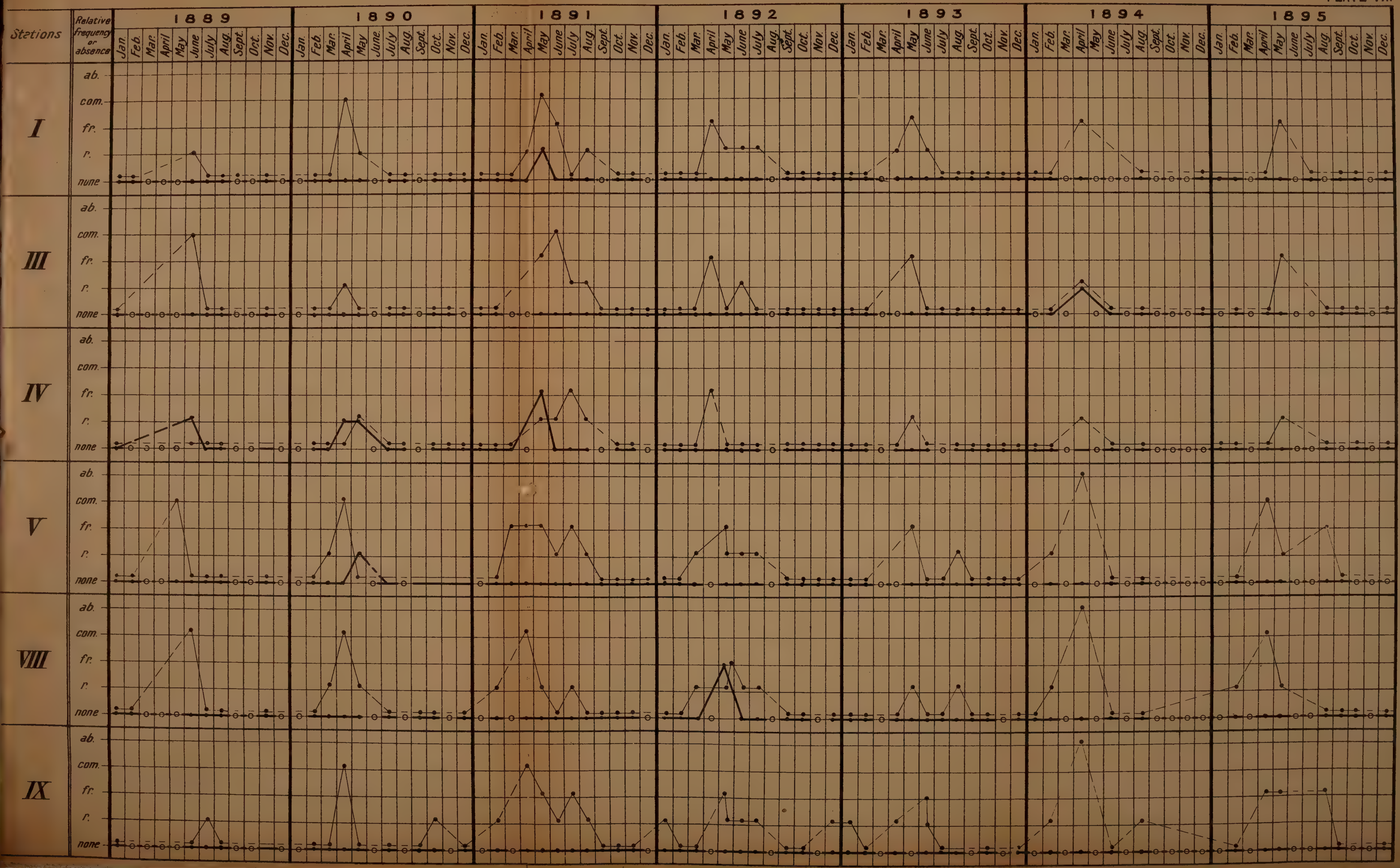


PLATE VII.

CHART showing the distribution and relative frequency of Pelagic Fish Ova in the Firth of Forth, as indicated by the records of them in the Lists of tow net gatherings referred to in the preceding notes.

Thick Lines = Bottom tow net Records. Thin Lines = Surface tow net Records.



(8.) LIST OF THE SPECIES OF MOLLUSCA AND CRUSTACEA REFERRED TO IN THE PRECEDING NOTES, AND SHOWING THE STATIONS WHERE THEY WERE OBTAINED.

Names of the Species.	Stations.						Remarks.
	Station I.	Station III.	Station IV.	Station V.	Station VIII.	Station IX.	
MOLLUSCA.							
NUDIBRANCHIATA.							
Doris sp. (? *repanda*, A & H.),		×					1890, in November.
Doto coronata, Gm.,			×				1890, in December.
Eolis sp. (1),				×			1891, in April.
Eolis sp. (2),	×						1895, in May.
LAMELLIBRANCHIATA.							
Cuspidaria cuspidata (Olivi),						×	1893, in April.
PTEROPODA.							
Limacina retroversa (Flem.),	×	×		×		×	Not uncommon.
Clione borealis (Brug.),		×			×		1889, Jan.; 1893, Dec.
CRUSTACEA.							
DECAPODA.							
Macropodia rostrata (Lin.),			×				1890 & '91, Oct. & Aug.
Crangon allmanni (Kin.),	×	×	×	×	×	×	Frequent.
Egeon fasciatus, Risso,		×					1891, in September.
Cheraphilus nanus (Kroyer),	×	×		×	×		Not very rare.
Hippolyte varians, Leach,				×			1890, December.
Hippolyte fascigera, Gosse,					×		1894 & '95, Jan., Feb.
Spirontocaris pusiola (Kroyer),			×				1895, February.
Pandalus montagui, Leach,	×	×		×	×		Not rare in tow-nets.
Pandalus brevirostris, Rathke,		×		×			1881, March, Sept.
SCHIZOPODA.							
Boreophausia raschii (M. Sars),	×	×	×	×	×	×	Mod. com., 1889-90.
Thysanoessa neglecta (Kr.),	×	×	×	×	×	×	Mod. com., 1891-92.
Siriella jaltensis, Czern.,				×			1893, March.
Siriella armata (M'Edw.),		×					1892, March.
Gastrosaccus spinifer (Goes.),	×	×		×	×	×	Not uncommon.
Heteromysis formosa, S. L. Smith,	×		×				1894-95, Aug., Feb.
Erythrops goesii, G. O. Sars,	×	×		×	×	×	Frequent.
Mysidopsis didelphys (Norm.),	×			×	×		1890-91, March.
Mysidopsis gibbosa, G. O. Sars,	×	×	×			×	Not uncommon.
Mysidopsis angusta, G. O. Sars,	×						1891, March.
Leptomysis gracilis, G. O. Sars,	×	×		×			1890-91, Oct.-Dec.
Leptomysis lingoura, G. O. Sars,		×					1892, March.
Hemimysis lamornæ (Couch),	×	×		×	×	×	Not very rare.
Macropsis slabberi (Van Ben.),	×	×	×		×		Locally frequent.
Praunus flexuosus (Müller),		×	×				Locally frequent.
Praunus inermis (Rathke),				×	×	×	1895, February.
Schistomysis spiritus, Norm.,	×	×	×	×		×	Not uncommon.
Schistomysis ornatus, G. O. Sars,	×	×	×	×	×	×	Frequent.
Neomysis vulgaris (J. V. Thomp.),			×				Locally frequent.
CUMACEA.							
Iphinoë trispinosa (Goodsir),	×						1889-90, July, Feb.
Cumopsis goodsiri (V. Ben.),		×					1891, September.
Leucon nasicus, Kroyer,	×			×	×		Not very rare.
Eudorella truncatula (Spence Bate),	×			×	×		Not very rare.
Diastylus rugosa, G. O. Sars,	×			×			Not very rare.
Pseudocuma cercaria (V. Ben.),	×	×		×	×	×	Frequent.
Campylaspis rubicunda (Lillj.),						×	1893, April; 1894, Aug.
Petalosarsia declivis (G. O. Sars),						×	1893, April.

Names of the Species.	Stations.						Remarks.
	Station I.	Station III.	Station IV.	Station V.	Station VIII.	Station IX.	
ISOPODA.							
Gnathia (?) *maxillaris* (M'Edw.),					×		1890, March.
Eurydice pulchra, Leach,		×					1890, November.
Idothea baltica (Pallas),	×	×	×	×	×	×	Frequent.
Idothea emarginata (Fabr.),	×						1891, May.
Idothea linaris (Lin.)			×				1893, January.
Janira maculosa, Leach,						×	1890, April.
AMPHIPODA.							
Hyperia galba (Mont.),	×	×	×	×	×	×	Frequent.
Hyperoche tauriformis (Bate),	×	×	×	×	×	×	Frequent.
Parathemisto oblivia (Kr.),	×	×	×	×	×	×	Sometimes common.
Euthemisto compressa (Goes),				×			1892, Feb., Nov.
Callisoma crenata (Bate),	×			×	×	×	1890, Oct.; 1893, Nov.; 1895, Dec.
Hippomedon denticulatus (Bate),						×	1894, February.
Bathyporcia sp.,			×				1894, February.
Ampelisca sp.,		×					1891, October.
Stenothoë marina (Bate),				×		×	1890, April.
Argissa hamatipes (Norm.),	×			×	×	×	Not uncom. at Outer St'ns.
Metopa alderi, Bate,	×	×		×	×	×	Not rare in bot. gatherings.
Periocalodes longimanus (Bate),				×	×	×	Frequent.
Iphimedia obesa (Rathke),				×			1892, January.
Apherusa bispinosa (Bate),	×	×	×	×	×	×	Frequent.
Apherusa borealis (Boeck),	×	×					Not very rare.
Paratylus swammerdami (M'Edw.),	×	×	×	×			Frequent.
Dexamine sp.,		×					Rare.
Melphidipella macera (Norm.),					×		1892, March.
Amathilla homari (Fabr.),			×				1892, December.
Gammarus sp.,			×				Rare.
Gammaropsis erythrophthalmus, Lillj.,				×			1890, December.
Dulichia sp.,						×	Rare.
Pariambus typicus (Kr.),		(?)	(?)		×	×	Not uncommon.
CLADOCERA.							
Evadne nordmanni,		×	×	×	×	×	Frequent.
Podon (?) *polyphemoides*,		×	×		×	×	Not uncommon.
COPEPODA.							
Calanus finmarchicus (Gun.),	×	×	×	×	×	×	Common.
Pseudocalanus elongatus, Boeck,	×	×	×	×	×	×	Frequent.
Temora longicornis (Müll.)	×	×	×	×	×	×	Common.
Centropages hamatus, Lillj.,	×				×		1889, June; '95, May, Dec.
Centropages typicus, Kr.,				×	×	×	1889, Aug.; 1890, Oct.
Metridia hibernica (B. & R.),						×	1892, May.
Candace pectinata, Brady,	×		×	×	×	×	Not very rare.
Acartia sp.,	×	×	×	×	×	×	Common.
Anomalocera patersoni (Temp.),	×	×	×	×	×	×	Frequent.
Parapontella brevicornis (Lub.),	×						1893, June.
Oithona (?) *similis*, Claus,	×		×				Occasionally frequent.
Thalestris longimana, Claus,		×					1891, June.
Thalestris serrulatus, Brady,	(?)					×	1891, June.
Alteutha depressa (?) (Baird),	×	×		×		(?)	Not very rare.
Dermatomyzon nigripes (B. & R.),	×						1894, August.
Monstrilla sp.,	×	×	×	×			1890-92, Aug., Oct.; 1893, Oct.
Caligus rapax (Müller),	×	×	×	×	×	×	Frequent.
ANELLIDA and MEDUSA.							
Sagitta bipunctata, G. & G.,	×	×	×	×	×	×	Common.
Tomopteris onisciformis, Esch.,	×	×	×	×	×	×	Frequent.
Aurelia aurita, Lam.,	×			×			Sometimes common.

VI.—NOTES ON SOME POINTS IN TELEOSTEAN DEVELOPMENT. By H. CHAS. WILLIAMSON, M.A., B.Sc. (Plates VIII. and IX.).

The following observations were made while I held the Exhibition (1851) Scholarship of the University of St Andrews. The work was carried on at the Zoological Station, Naples, and at the Gatty Marine Laboratory, St Andrews. At Naples I was afforded the privilege of occupying the table of the British Association.

THE ABSORPTION OF THE YOLK, AND THE PRIMITIVE CIRCULATION IN PELAGIC TELEOSTEAN OVA.

The process of the absorption of the yolk in Teleostean ova is not one which has received much direct attention. In *demersal* eggs the absorption of the yolk is mainly effected by means of an elaborate vitelline *blood* circulation. In *pelagic* ova, with one or two rare exceptions, no vitelline blood circulation exists. The study of the subject involves an examination almost solely of *live* eggs.

I find that in those pelagic ova which I have been able to examine there is a distinct, though very much modified, vitelline circulation. The elements of this circulation are not, however, blood corpuscles but *yolk* corpuscles. I have noticed this circulation in the ova of the following twelve species, viz. :—Three species of the ova of *Murænidæ* (Raffaele),* *Merluccius vulgaris*, *Engraulis encrasicholus*, Species No. 3 (*Coryphæna?*) Raff., * *Gadus æglefinus*, *Gadus merlangus*, *Pleuronectes italicus* (*?*), *Pleuronectes flesus*, *Pleuronectes limanda*, *Clupea sprattus*, *Uranoscopus scaber*. In the case of the last-named species, I refer to a stage previous to the appearance of the complete blood circulation.

The corpuscles which form the elements of the circulation are simply little portions of periblast. They are clear, transparent bodies of varying size and shape. They are, for the most part, roughly spherical or oval in form, and show no distinct bounding wall. They are merely little naked portions of protoplasm. Before the heart is formed these corpuscles are to be seen scattered over the periblast. When the heart begins, at first slowly and feebly, to pulsate, the corpuscles begin to move over the periblast towards it. (The venous end of the heart opens into the interior of the yolk sac). Once free from the periblast they enter the heart, and from it are pumped through the already formed vessels. These consist in, two lateral arteries (*b.v.*, figs. 1 and 15)—the forerunners of the branchial veins—uniting to form the aorta, which runs posteriorly to a point a little short of the tip of the tail; and the caudal vein (*c.v.*, fig. 7), which, arising near the tip of the tail, debouches into the posterior end of the yolk sac.

At first the number of corpuscles entering the heart from the yolk sac is small, but, as development proceeds, the number increases gradually. The inner surface of the yolk sac is lined with a layer of periblast, and on it are to be seen numbers of corpuscles. In the embryo of the anchovy the yolk corpuscles are very large; they are round or oval, show no visible nucleus, and are almost twice as large as ordinary blood corpuscles; they show a fairly distinct boundary, though not so well defined as that of a blood corpuscle. The yolk corpuscles in the egg of Species No. 3, Raffaele, are round or oval homogeneous refractive bodies; some are pear-shaped, with a fairly well drawn-out point, others are irregularly cubical.

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* Raffaele, "*Uova galleggianti del Golfo di Napoli,*" Mittheil, Zool. Station, Neapel Bd. 8. 1888.

The corpuscles, when moving towards the heart (*c.*, figs. 11 and 12), proceed either singly or in masses. Some move with a uniform slow motion, while others move in a jerky motion. The latter movement is especially seen as the corpuscles near the mouth of the heart; they then, with each pulsation of the heart, oscillate backwards and forwards in a sort of pendulum motion. The length of the recoil is always less than the anterior advance, and so the corpuscle ever gets nearer the heart, the velocity of its oscillations steadily increasing until it arrives at and enters the heart. They are then seen passing along the aorta to the tail, and immediately thereafter appear in the caudal vein, from which they pass into the yolk sac; they proceed over the ventral surface of the yolk and re-enter the heart. Some of the corpuscles pass directly from the posterior end of the yolk sac to the heart without stopping; others stick to the periblast and remain attached for longer or shorter intervals. On the posterior surface of the yolk, where the caudal vein enters the yolk sac, the periblast shows a well-marked furrow which has been worn in it by the circulating fluid. That there is some sort of circulating fluid present seems extremely probable, though its existence is not easily demonstrated. The first corpuscles then are formed in the periblast and pass into the heart with the circulating fluid.

There is, however, a second method by which corpuscles are added to the circulation, and that is by a process of budding. Soon after the heart begins to pulsate processes are thrown out from the periblast covering the anterior end of the yolk. These processes have various forms: some are slender and pseudopodium-like, with finely drawn-out tips (*p.* and *yp.*, figs. 2, 4, and 14), others have swollen apices (*p.*, figs. 6 and 18). The club-shaped process represented in fig. 18, *yp.*, arises from the thick layer of protoplasm surrounding the oil-globule. In the swollen head of the process there is a small refractive globule. This process sways to and fro with the pulsations of the heart. Little blunt papillæ are also present in the periblast. From the tips of these processes little corpuscles are budded off. The tip of a process slowly swells out into a little sphere, and when the latter attains a size at which the attraction of the heart overcomes the surface tension of the protoplasm it breaks off and moves towards the heart. This process of budding is extremely slow. In figs. 5 and 5A a corpuscle (*c.*) is shown which has just been budded off from the papilla (*p.*). These pseudopodium-like processes are seen in all of the species mentioned above. The corpuscles which are budded off do not appear to differ from the primary corpuscles seen on the periblast. They are irregular in shape and form, and appear, in some cases at least, to have nuclei.

In the ova of *Murænidæ* (Raffaele) the yolk sac is very large. The yolk is almost all absorbed before the larva hatches. As the yolk is absorbed the empty space in the yolk sac is filled up by an æsophageal pouch* (*b.s.*, figs. 11, 12, and 14). This is a dilatation of the æsophagus which projects into the yolk sac. At first small, it increases steadily in size as the yolk decreases; just before hatching it fills almost the whole of the yolk sac. This pouch thus lessens the area upon which the heart has to act, and therefore increases the efficiency of the heart in the work of disintegrating the periblast. It probably also subserves a respiratory function. It almost completely disappears on hatching (*b.s.*, fig. 3).

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* *Borsa stomacale* (Raffaele).

The circulating corpuscles are used up at the growing parts, and very few return to the yolk sac until after hatching, when the yolk sac becomes simply a wide vessel conducting the corpuscles to the heart from the caudal vein. When the larva hatches there is not so great a demand made upon the yolk and the tissues, and there is, therefore, a copious supply of yolk corpuscles circulating in the vessels; this is especially well seen in the eggs of *Murænidæ*. At hatching the vertebral vein (*v.v.*, fig. 27) has appeared, and also the *ductus Cuvieri* (*d.c.*, figs. 3 and 27). Large numbers of corpuscles enter the *sinus venosus* (anterior portion of the yolk sac) (*s.v.*, fig. 3) by the *ductus Cuvieri* and from the posterior portion of the yolk sac.

In an egg measuring ·94 mm. diameter, and having an oil globule (posterior), a stream of small granules (*gr.*) resembling the nuclei in the periblast was seen passing from the caudal vein (*c.v.*) into the yolk sac (fig. 7).

CIRCULATORY SYSTEM.

At the time of hatching, the system of vessels in which the yolk corpuscles circulate is as follows:—The heart opens by its venous end into the yolk sac. From the heart the corpuscle passes into the first *aortic arch* (*a.a.*, fig. 1), whence it proceeds to the *lateral artery* (*b.v.*, fig. 1)—the forerunner of the branchial vein. The two lateral arteries unite to form the *dorsal aorta* (*d.a.*, figs. 1 and 15), by which the corpuscle is conducted to a point a little short of the extremity of the tail. It is brought anteriorly again by the *caudal vein* (*c.v.*, fig. 25), which lies along the base of the anal marginal fin. The caudal vein crosses the rectum and debouches into the posterior end of the yolk sac (*p.e.*, fig. 25). In the head the circulation, as far as was made out, is as follows:—From the lateral artery the corpuscle passes into the *carotid artery* (*c.a.*), and from the latter passes by the *ocular artery* (*o.a.*) to a *lacuna* (*l.*) round the lens of the eye (figs. 1 and 7). The continuation of the carotid anteriorly was not made out. From the lacuna round the lens the corpuscle returns by the *ocular vein* (*o.v.*, fig. 1) to the *jugular vein* (*j.v.*, figs. 1 and 7), which may be single (fig. 7) or double (fig. 1). Where the jugular vein is single it divides into two branches (*v.a.* and a^1., fig. 7), which open, one on each side, into the yolk sac at a point ventral to the ear capsules. Where there are two jugular veins (fig. 1), they open, one on each side, into the yolk sac in the same region.

The yolk sac acts simply as a large vessel.

There is thus in the *pelagic* egg a circulatory system exactly *homologous* to the circulatory system in a *demersal* egg; the only difference is in the arrangement of the system in the yolk sac. In the pelagic egg the yolk sac is one large vessel; in the demersal egg it is broken up into a network of vessels.

THE RESPIRATION OF THE TELEOSTEAN EMBRYO.

A comparatively elaborate respiratory system is developed in the teleostean embryo. The main organ of respiration in the embryo is the gut, or, more correctly, the delicate embryonic canal which is the forerunner of the gut proper. Where the term "gut" is used in this paper, this rudimentary gut is referred to.

The gut (*g.*) appears in the embryo of *Trachinus vipera* just after the closure of the blastopore, at which stage the cardiac swelling alone indicates the position of the future heart (fig. 23). It is a narrow tube with delicate walls; its anterior end stops short of the pectoral region, and it extends posteriorly to the end of the tail. In its middle portion the gut widens considerably. Its hind extremity is somewhat obscured by the thick mass of loose tissue at the end of the tail, but it appears to open out in a funnel-shaped aperture. In the egg of *Serranus hepatus*, before the heart begins to pulsate, at a stage when the tail reaches a little beyond the yolk, the gut is not well defined and appears to have minute lateral branches. In the egg of the anchovy (*Engraulis encrasicholus*) also the spaces between the muscle segments resemble fine canals and appear to be connected with the gut. A communication by means of these canals between the gut and the subepiblastic space probably exists. In the egg of the anchovy when the blastopore closes there is no trace of the gut. There is a distinct longitudinal space lying below the neurochord, bounded laterally by the ventral halves of the muscle segments, and ventrally by the hypoblast (*ns.*, fig. 22). This space appears to be filled with a homogeneous fluid in which there is no trace of cells. In an egg measuring ·94 mm. (and having an oil globule ·19 mm. in diameter), in which the tail of the embryo was just appearing above the yolk, such a subnotochordal space was well seen. In the same egg, at a little later stage—but before the cardiac swelling had appeared—the gut was already formed. In the egg of Species No. 3 (Raffaele),* when the blastopore closes there is no trace of the gut.

The next stage in the development of the gut is marked by the forward extension of the gut and the appearance of the two "*pre-opercular apertures*" (*p.o.a.*). one on each side. The pre-opercular apertures open by funnel-shaped mouths to the *perivitelline space*; from each aperture (*p.o.a.*) a canal runs to the middle line of the embryo and joins the anterior end of the gut (fig. 21); the apertures are situated immediately ventral to the ear capsules. The heart is not yet formed. The anterior portion of the gut is now ciliated (*c.*, fig. 21). The cilia vibrate from before backwards, thus causing a current to enter from the perivitelline space by the pre-opercular apertures and to pass posteriorly along the gut. The fluid in the perivitelline space—which differs from sea water only in possessing certain minute corpuscles—thus passes through the gut to find exit in the loose tissue of the tail. Outside each pre-opercular aperture there are the so-called "*pectoral filaments*"; these (*p.f.*) are simply finger-like grooves uniting at the mouth of the pre-opercular aperture (figs. 9, 21, and 20). A few corpuscles are seen at the ends of the filaments.

In the egg of *Serranus hepatus*, at the stage when the heart commences to pulsate, the gut has very irregular walls. The extremity of the tail has the appearance of being broken up into a number of canals. The gut is continued anteriorly as far as the front end of the notochord by a canal of the same width as itself. The cilia are vibrating actively in the æsophageal portion of the gut. In the egg of anchovy also, when the tail of the embryo projects a little beyond the yolk, an anterior continuation of the gut to the head exists.

The cilia in the gut do not act continuously, but intermittently; it is only at the moment when they are actively vibrating that it is possible to make them out.

In the egg of *Trachinus vipera,* when the embryo is two-thirds developed, an anterior continuation of the gut is seen. This anterior canal divides into two branches—one of which proceeds to a pore on the dorsal surface of the head, while the second branch opens by a pore on the ventral surface of the same (fig. 24); this anterior prolongation of the gut is not present in all species. Thus, in the embryo of the hake (*Merluccius vulgaris*), when it is ready to hatch, the gut does not extend further forward than the level of the pre-opercular apertures. In no case was a connection between the gut and Kuppfer's vesicle distinctly made out.

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* *l. c.*

In later embryonic stages it is very often difficult to see the ciliated portion of the gut (viz., in the pectoral region). This fact is due to the great development of tissue which goes on ventral to the gut in that part. Thus, in an egg ·9 mm. in diameter (probably belonging to the *Mugil* species), the gut shows a very distinct, though very delicate, limiting wall. At first sight the gut seems to end at the level of the junction of the two lateral arteries (branchial veins); but that fact is due to the thick plate of tissue lying ventral to and obscuring the æsophageal portion of the gut. The æsophageal ciliated portion could be made out with difficulty. In the embryo of the dab (*Pleuronectes limanda*) similarly the gut appeared to end short of the pectoral region.

In other embryos—*e.g.*, that of anchovy—the ciliated portion of the gut is not easily seen owing to the great translucency of the tissues; and so the ciliated portion of the gut is seen earlier in one species than in another. This is probably not due to the cilia actually appearing at a later stage in the latter. In the case of a very translucent embryo it is only in later development that the tissues attain a density sufficient to cause the cilia to become visible by contrast.

In the embryo of the plaice, when two-thirds developed, the pectoral filaments have the appearance of a collection of large cells loosely packed together, with channels running from them (*p.f.*, fig. 20); it is not improbable that these are cells of the epiblast of the yolk sac. In an embryo ready to hatch the pectoral filaments have a resemblance to fine reticulations somewhat similar to minute canals. Posterior to the pectoral region there are fine reticulations on the yolk alongside the embryo; they are probably the rudiments of the pectoral and pelvic fins. At this stage the walls of the dilatation of the gut (stomach) are thickened very much, taking on the structure of the larval gut. The gut is continued posteriorly along the base of the marginal fin, apparently breaking up into a number of thread-like tubes as it nears the extremity of the tail, where the caudal marginal fin is slightly dentate.

In the embryo of the anchovy, when it is ready to hatch, the gut is ciliated in several parts (*c.*, etc., fig. 19).

In the larva of anchovy the pre-opercular apertures are widened, and open into the pharynx. The wall of the æsophagus, which is narrow, is very irregular. The lumen of the gut is slender; the walls are thick. The anus opens at the middle of the width of the marginal fin on the right side of the same.

The gut in the larva of the whiting (*Gadus merlangus*) is shown in fig. 17. The rectum is constricted off from the intestine at *con.* A peristaltic movement takes place in the rectum; the movement begins at the constriction and passes backwards in a wave motion. As the rectum contracts the anus opens, and *vice versa.* Small rod-like bodies are seen moving about in the rectum. The anus has three peculiar lobes. It opens apparently in the space between the two leaves of the marginal fin. From the anus grooves run out to the fin-margin, and they probably indicate the position of a tube leading from the anus to the exterior (*grv.*, fig. 16).

Sub-epidermal Space.—Between the epiblast and the muscle segments there is a comparatively wide space. The epiblast is a loose covering to the embryonic trunk (mesoblast and nervous system). In the embryo of anchovy this space is especially wide. Corpuscles were seen in this space in the larva of *Scorpæna* species. The space is evidently filled with a fluid of some nature, and, in certain embryos—*e.g.*, anchovy, *Mugil*, etc.—it seemed to be connected with the gut by the intermuscular spaces. A not improbable hypothesis is that the perivitelline fluid which enters the gut also circulates in this space ; but at present no direct proof is adducible in support of this suggestion.

The respiration of the embryo has not hitherto been regarded as involving any special system of vessels. Respiration is supposed to take place directly through the tissues at every part of the embryo—a process of osmosis. Whether such a method is sufficient for complete aeration in certain eggs is not of material moment; but that that method is not the sole one is shown by the existence of the specialised respiratory system of which the gut is the principal organ. In the embryo the whole gut is used for respiration; in the young fish the pharynx is supplied with special respiratory organs--viz., gills—and through them alone respiration is carried on. In the embryo the perivitelline fluid probably circulates in the sub-epidermal space, to which it may obtain entrance by the spaces between the muscle segments or by the anterior prolongation of the gut seen in certain embryos. A fuller examination of the respiratory system is required before its exact circulation can be determined.

LATERAL SENSE ORGANS.

The name "lateral sense organs" has been given to the small papillæ which appear, just before hatching, on the sides of the embryo. They are usually paired—the papilla on one side being exactly opposite a corresponding papilla on the other side. On the tail, however, the papillæ are are not all paired; the most posterior papilla is usually single.

The lateral sense organs in the larva are described as papillæ bearing externally a number of palpocils or sensory hairs. Ryder drew attention to them in the cod (*Gadus morrhua*), and mentioned that each papilla receives a small nerve twig from the spinal cord; this nerve crosses the sub-epiblastic space.

In the embryo of anchovy the lateral papillæ are well seen (*l.p.*, fig. 8). Small pear-shaped corpuscles project from the papillæ. A long protoplasmic process was attached to the apex of one papilla (*l.p*^{1}., *ib.*). The summit of the papilla usually has a small depression or dimple in it. The papillæ gradually diminish in size as they near the end of the tail.

In a larva of anchovy, just hatched, the small pear-shaped corpuscles were attached to the papillæ. Behind the anus were two pairs of these organs, and of these the more posterior pair, though the smaller, had a double form. In the anchovy larva, however, there is usually a delicate tube projecting from each papilla at right angles to the side of the embryo (*l.p.*, fig. 26). The distal portion of the tube is bent backwards. There are seven papillæ on the right and six on the left side. The first six papillæ on each together form pairs; the seventh is unpaired. In the larva of Species No. 3 (Raff.) there are five papillæ on each side (*l.p.*, fig. 10); the first two form pairs with their fellows on the opposite side; the remainder do not form pairs. The anterior three papillæ on each side are alone furnished with external tubes. Small lateral papillæ are present in the larva of *Mugil* species. One papilla had a pore-like depression in its summit, while a second had a corpuscle attached to its apex.

Almost all the tubes have a number of small granules in their distal portions (*l.p.*, fig. 26); these granules remain quite stationary. The fibres of the tube enter the papilla and give the origin of the tube a slightly wrinkled appearance. In one case at least the tube was evidently continued into the papilla.

In the larva of *Scorpæna* species, and in an unknown larva (probably *Osmerus* species), the lateral papillæ with their tubes were easily made out.

These tubes have been described as palpocils. The reasons why I prefer to regard them as tubes and not as sensory hairs are :—(1) That the sides of the tube are always perfectly parallel, and the fibres are all parallel to one another ; if they were simply palpocils they would certainly sometimes show a crossing and interweaving of the independent hairs ; (2) when the tubes are bent backwards their shape and diameter are perfectly retained—a condition which could not exist if the fibres were separate hairs.

What the function of these tubes may be it is difficult to understand. I have in no case been able to make out any nerve supply. That they are the rudiments of the lateral sense organs of the adult is more than doubtful ; they are evidently not rudimentary organs, but subserve some function in the larva ; so elaborate organs for a sensory function in the larva would appear superfluous.

A not improbable hypothesis is that they act as exits to the fluid circulating in the sub-epiblastic space. The papilla itself might be regarded as a sort of sphincter to the tube.

EXCRETORY (?) PRODUCTS IN THE GUT.

In an embryo of anchovy were seen small *greenish* granules, collected in spherical masses, at certain points (*c.*), in the gut, or isolated between these points (*c.*, fig. 19). The little masses are revolving at a rapid rate at the places (marked *c.* in the sketch) where the gut shows slight dilatations. The isolated granules oscillate backwards and forwards—at one time approaching, at another receding from the masses next them. At each vortex, indicated by the motion of the masses of granules, there is a group of cilia. The rectum is filled with similar granules.

In a newly-hatched larva of anchovy the granules were seen to issue from the anus ; in several larvæ, granules similar to the above were seen lying on the marginal fin outside the anus, while other granules were present in the gut and rectum.

In the larvæ of *Scorpæna* species small granules were seen whirling round in the wide intestine and in the rectum ; in the gut of the embryo of plaice granular masses were seen ; while in the larva of whiting rod-like bodies were seen moving about in the rectum (*r.*, fig. 17).

Whence do these granules come? They are seen before the mouth opens, and before there is a blood circulation. It is extremely improbable that any digestion goes on in the gut ; but that excretory products are formed in the embryo is undoubted. Certain changes take place—*e.g.*, the change or conversion of the non-staining yolk into the staining periblast, the formation of cells and cell walls, and respiration. There must be excretion accompanying the growth The gut is the recipient of part of the excretory products—viz., of respiration ; and it is not improbable that other excretory products pass by osmosis from the growing tissues into the gut, to be expelled by the anus.

EXPLANATION OF PLATES.

Plate VIII.

Fig. 1. *Uranoscopus scaber*, Head of Embryo. 15/6/96.

Fig. 2. Egg of Haddock (*Gadus æglefinus*). 28/4/97.

Fig. 3. Larva—Species No. 6, Ova of *Murænidæ*, Raffaele. 22/8/95.

Fig. 4. Egg of Anchovy (*Engraulis Encrasicholus*). 26/5/96.

Fig. 5. Species No. 6, Ova of *Murænidæ*, Raff.; same Egg as Fig. 3. 24/8/95.

Fig. 6. Egg of Anchovy (*Engraulis Encrasicholus*). 3/6/96. Shows processes from the periblast.

Fig. 7. Egg measuring ·94mm. in diam., having an oil-glob. ·19mm. in diam. ; probably Egg of *Merluccius vulgaris* (Hake). 13/6/96.

Fig. 8. Egg of Anchovy. 22/4/96.

Fig. 9. Egg measuring ·98mm. in diam.; probably Egg of *Pleuronectes italicus.*

Fig. 10. Larva of Species No. 3 (*Coryphæna ?*), Raffaele. 10/6/96.

Fig. 11. Same Egg as Figs. 3 and 5. 26/8/95.

Fig. 12. Same Egg as Fig. 3.

Fig. 13. Egg of Species No. 9 (Ova of *Murænidæ*). 13/8/95.

Fig. 14. Same Egg as Fig. 3. 23/8/95.

Fig. 15. Egg of *Mugil* (?) Species, measuring ·91mm. in diam., with posterior oil-globule ·18mm. in diam.

Plate IX.

Fig. 16. Larva of Whiting (*Gadus merlangus*), anal region. 29/4/97.

Fig. 17. Larva of Whiting, anal region. 29/4/97.

Fig. 18. Same Egg as Fig. 13. 12/8/95.

Fig. 19. Egg of Anchovy. 28/5/96.

Fig. 20. Head of Embryo of Plaice (*Pleuronectes platessa*). 30/4/97.

Fig. 21. Egg of Lesser Weever (*Trachinus vipera*). 5/4/96.

Fig. 22. Egg of Anchovy. 8/6/96.

Fig. 23. Egg of *Trachinus vipera.* 3/4/96.

Fig. 24. Egg of *Trachinus vipera.* 4/4/96.

Fig. 25. Larva of Anchovy (tail region). 19/6/96.

Fig. 26. Larva of Anchovy. 30/5/96.

Fig. 27. Larva of Species No. 6 (Ova of *Murænidæ*). 24/8/95.

LETTERS USED.

a, anus ; *aa*, aortic arch ; *bl*, urinary bladder ; *bs*, æsophageal pouch (*borsa stomacale*) ; *bv*, branchial vein ; *c*, cilia, *c* Fig. 19, masses of granules ; *ca*, carotid artery ; *cd*, caudal artery ; *cv*, caudal vein ; *da*, dorsal aorta ; *dc*, ductus cuvieri ; *f*, furrow on yolk at mouth of caudal vein ; *g*, gut ; *gb*, gall bladder ; *gr*, granules ; *grv*, grooves ; *ht*, heart ; *jv*, jugular vein ; *l*, lacuna, *la*, branchial vein ; *li*, liver ; *lp*, lateral papilla ("lateral sense-organ") ; *mf*, marginal fin ; *ns*, subneural space ; *oa*, ocular artery ; *og*, oil-globule ; *ov*, ocular vein ; *p*, process ; *pb*, periblast ; *pc*, pericardium ; *pe*, posterior end of yolk ; *pf*, pectoral filament ; *poa*, pre-opercular aperture ; *sg*, segmental duct ; *sv*, sinus venosus ; *va*, *vá*, opening of jugular vein ; *vv*, vertebral vein ; *y*, *yk*, yolk ; *yks*, yolk-sac.

PLATE VIII.

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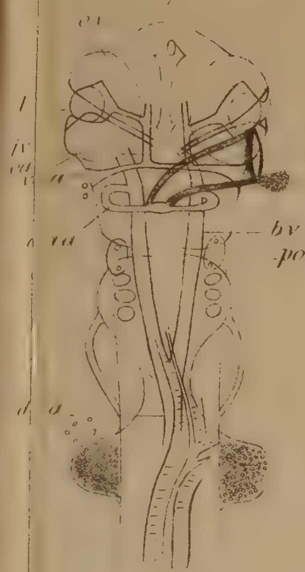

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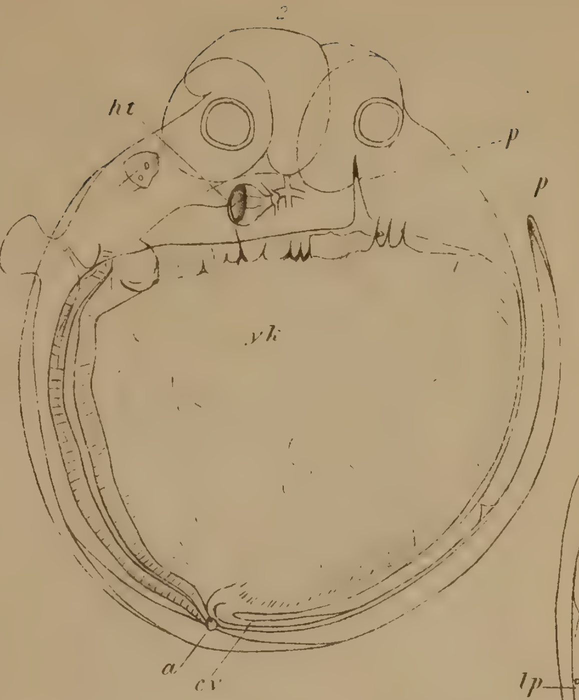

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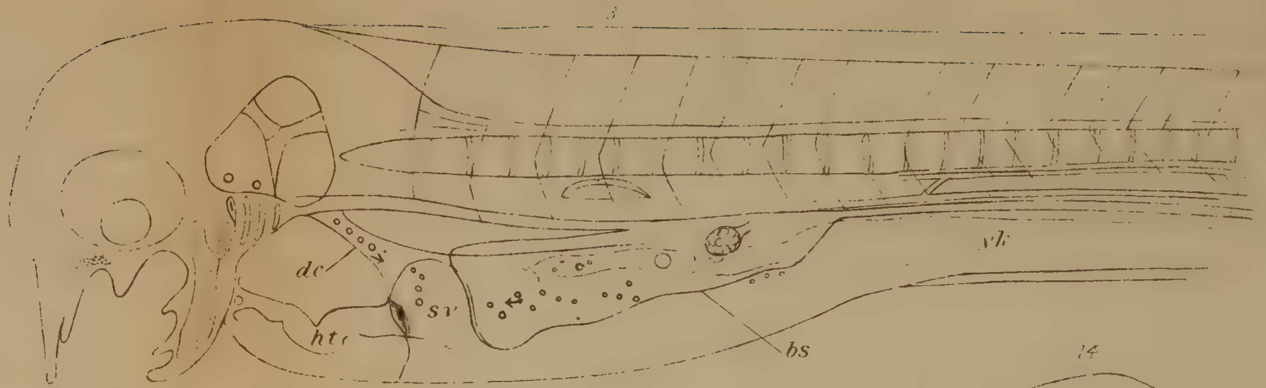

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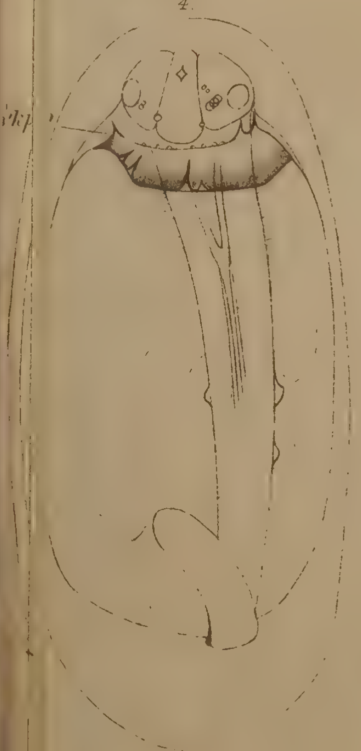

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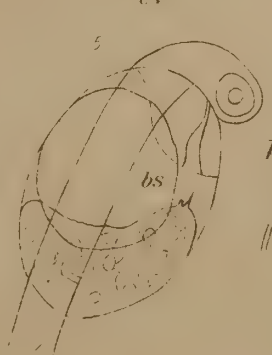

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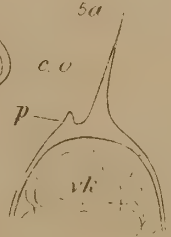

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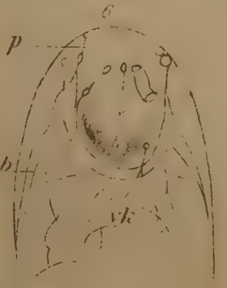

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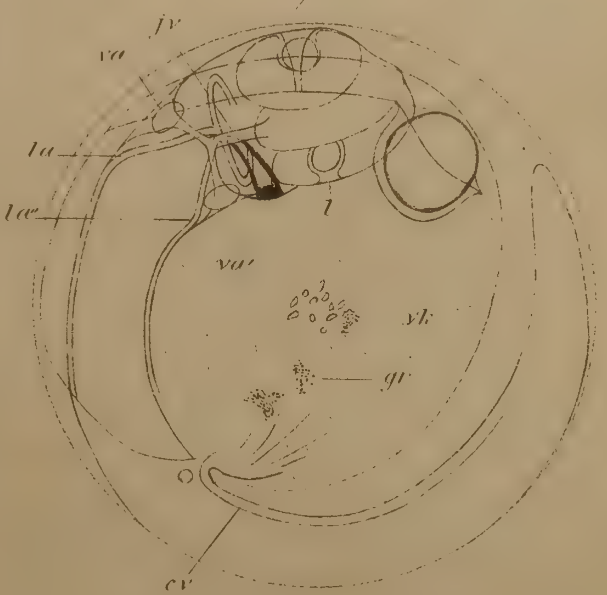

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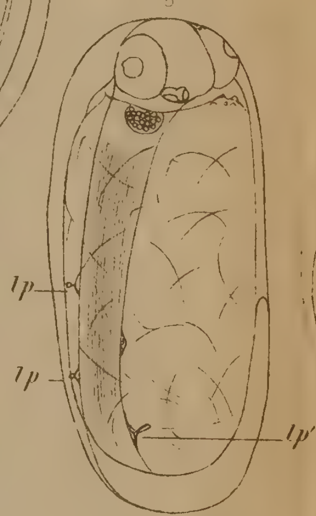

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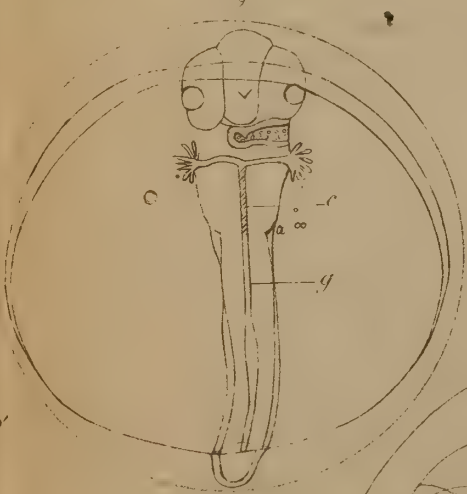

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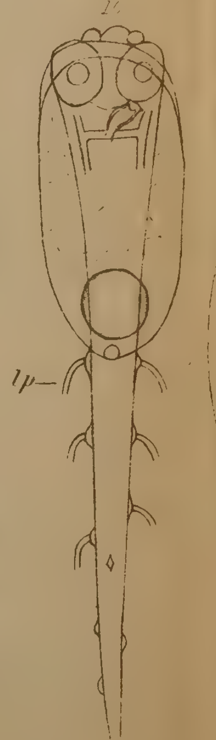

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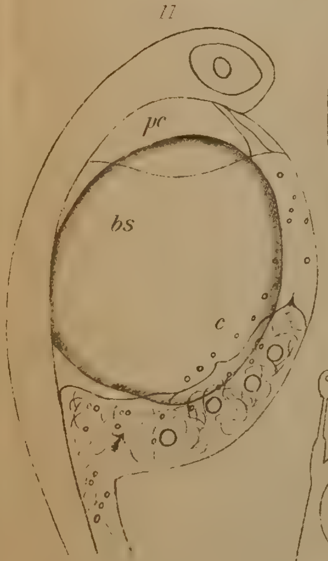

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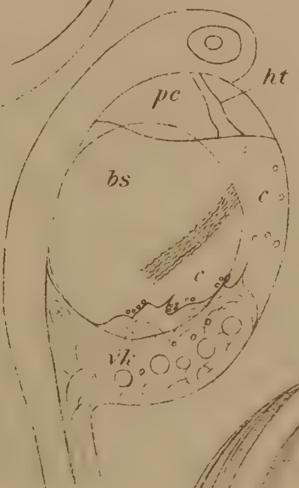

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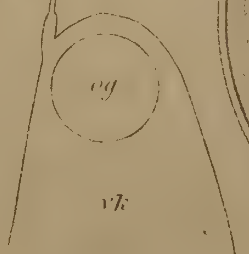

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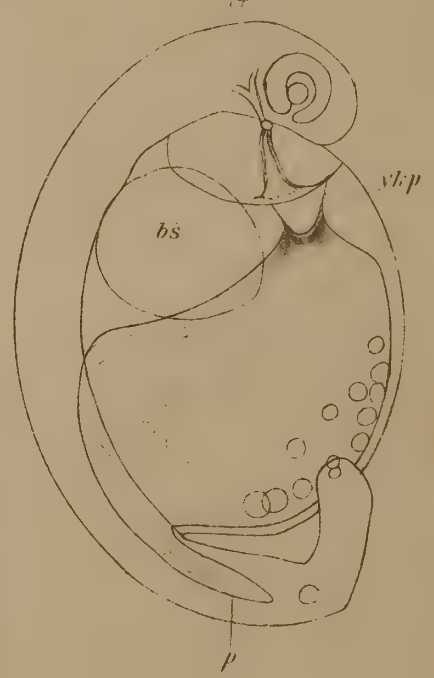

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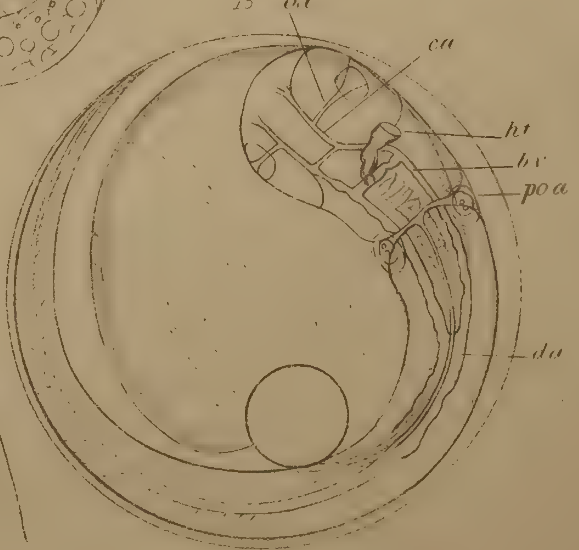

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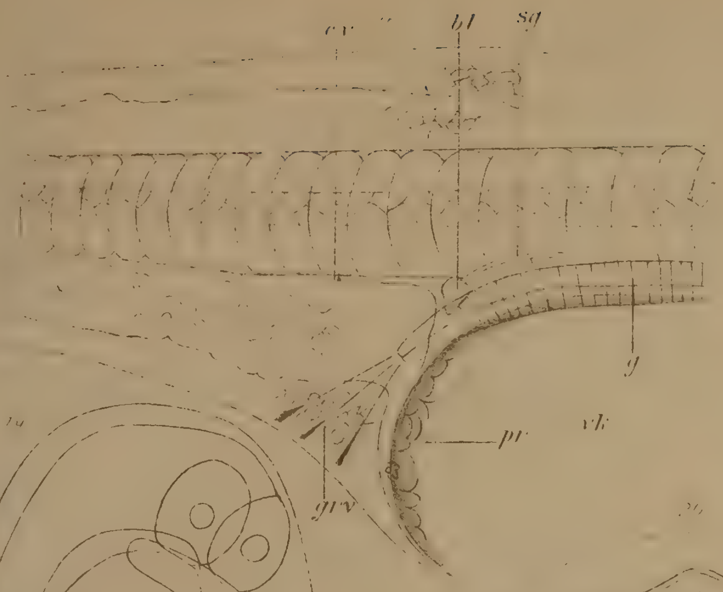
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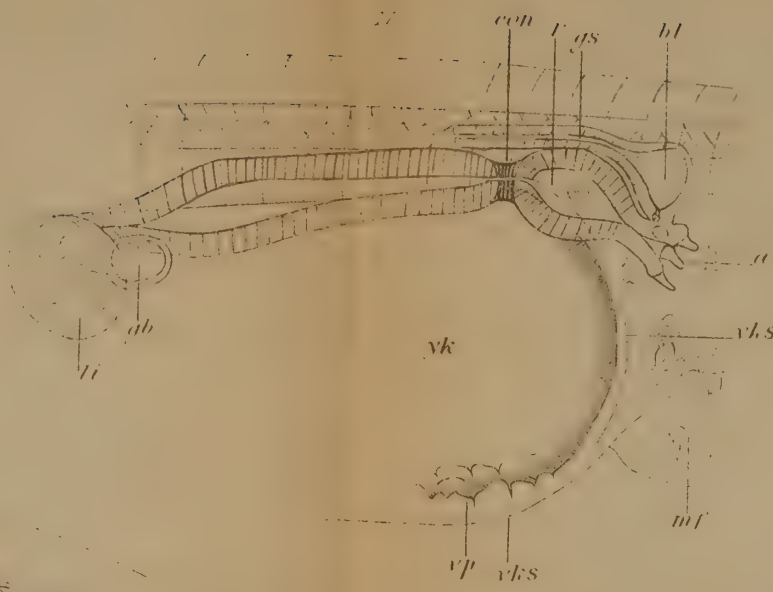
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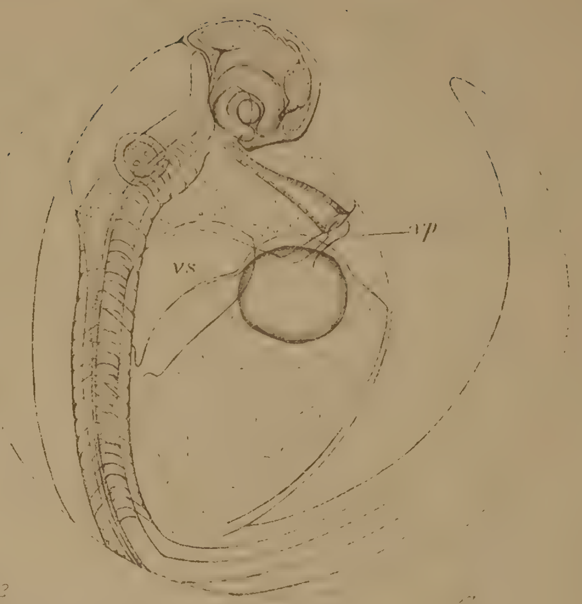
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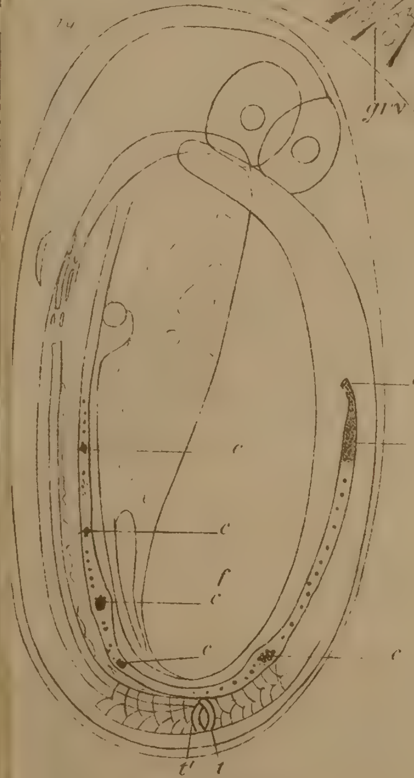
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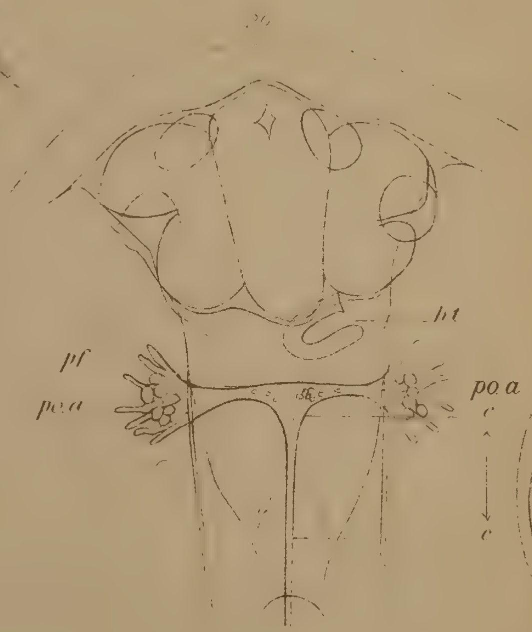
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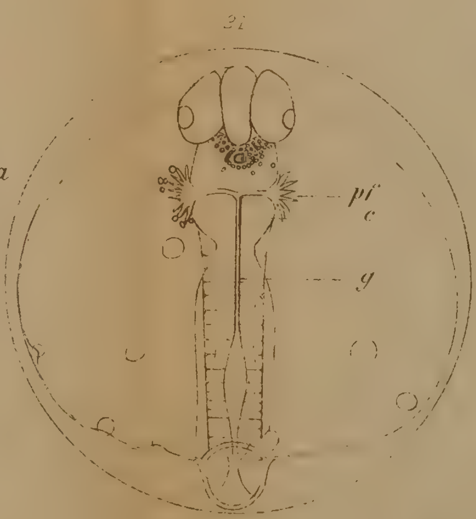
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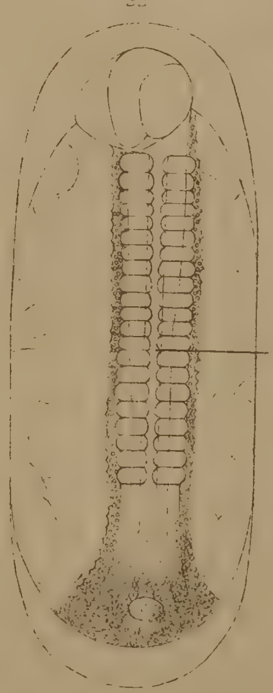
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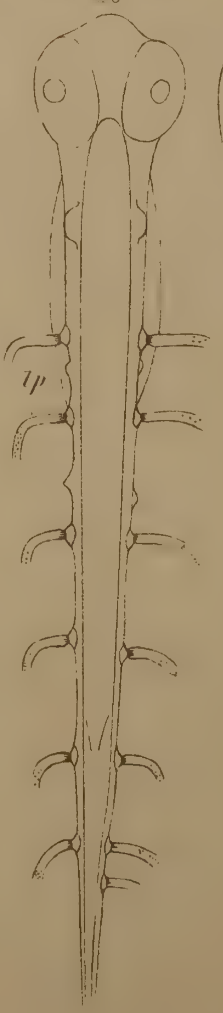
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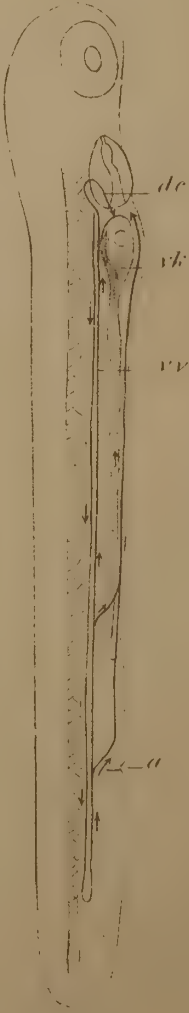
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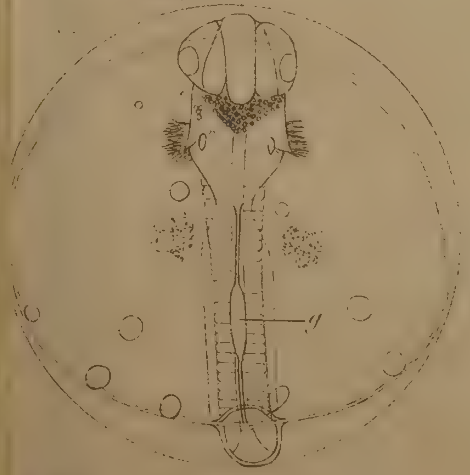

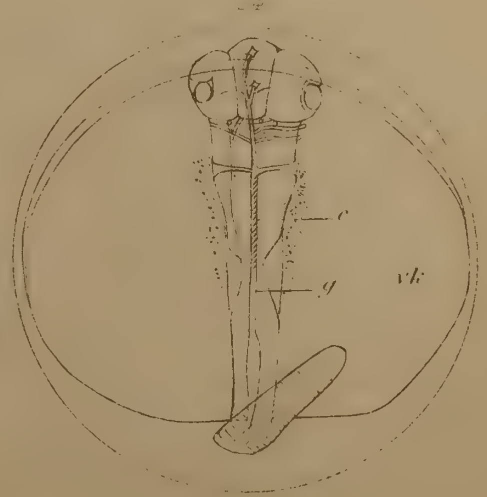
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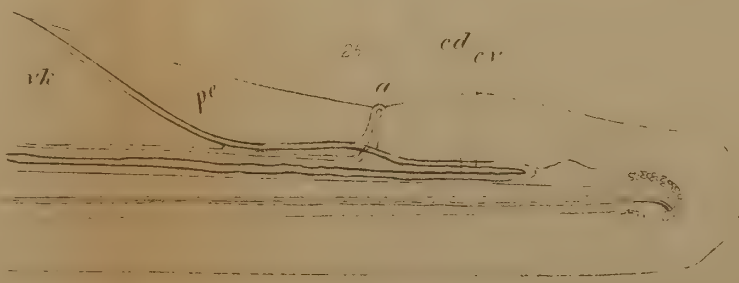
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VII.—REPORT ON THE OPERATIONS AT DUNBAR MARINE HATCHERY for the Period July 1896 to December 1897, with some NOTES ON REARING EXPERIMENTS WITH FLAT FISHES.

By Harald C. Dannevig.

In my last Report on the operations at the Dunbar Hatchery, I described experiments that had been carried out on the breeding of turbot and lemon soles in the summer of 1895, and also reported on the hatching of plaice during the spring season 1896. In the following pages an account is given of the hatching work that has been carried out since then up to the present (February 1898).

1. Experiments with Turbot.

These were carried out in a modified form in accordance with the experience obtained in 1895. From the report of that year it will be seen that ripe fishes were transported from the West Coast and kept in the tanks at Dunbar. Though the fishes were in an apparently thriving condition they did not spawn naturally, a consequence, no doubt, of the confinement immediately before the spawning season, and of the narrowness of the tanks. It was therefore decided to collect immature turbots locally and rear them in confinement till they reached maturity. This collection was at once begun, and by the end of 1896 about eighty fishes had been gathered. They measured from 10 to 14 inches in length, and were captured by a small shrimp trawl on the shallow sands in the neighbourhood of Dunbar. Fertilised turbot eggs were also transported from the West Coast to Dunbar in the same way as had previously been done with the fishes, a few millions being obtained in good condition, from which 1,360,000 fry were produced. The collection of immature turbot has been continued during 1897, and by the end of the year about 200 healthy fishes were kept in confinement here, measuring from 10 to 16 inches. They are well fed and in good condition, so that confinement at this early age does not seem to affect them in the least; and if they were placed in a larger tank I have no doubt that in due course they will produce eggs abundantly.

2. Experiments with Breeding of Lemon Sole.

The experiments were continued during the summer of 1897. In the previous year an attempt had been made to collect these valuable flat fishes from the trawlers, but most of them died soon after being landed. By an improved treatment of the fishes in the tanks it was thought a much larger percentage might survive the bad effects of the capture and transport to Dunbar, and by collecting a large number (about 1150 fishes were landed altogether) there was some hope that a fair number of healthy spawners could be secured. It was found, however, that the previous year's experience was repeated, as more than 700 fishes died within a couple of days after they were landed. This number included nearly all the females, which, owing to their advanced stage of development, were less hardy than the males. The difficulty experienced with the lemon sole is a direct consequence of the rough way in which the fish is captured by the ordinary trawlers, and in order to secure a healthy stock of spawners of this valuable flat-fish other means must be employed. The most successful method would be to collect from near the coast nearly mature fish measuring from 10 to 12 inches, and mature them in confinement as is being done with the turbot. Most of the lemon soles of the above-mentioned size would become mature in one or at most in two years. But in order to deal with this flat-fish in this way it would be necessary to obtain more accommodation in the way of tidal tanks than exists at present at Dunbar.

3. On the Hatching of Plaice during the Spring Season 1897.

The spawners were this year, as usual, collected from the steam trawlers by the *Garland*. From February 3rd to March 15th 603 fishes were landed and at once placed in the spawning pond. Fertilised eggs were first observed in the last week of February, and on the 22nd the first collection was carried out, about two weeks earlier than in any other year. The spawning season ended on May 11th, when altogether 30,960,000 eggs had been obtained. Of these about 92 per cent. were successfully hatched and the young fry transported to Loch Fyne. A number of fry was lost during the transport, principally owing to the often rough usage that the apparatus got in the hurried changes in railway stations and handling elsewhere. Precautions have been taken to obviate this difficulty, so that such losses in future will be reduced to a minimum. Table I. shows the daily progress of the hatching work, while Table II. gives particulars in regard to the distribution of the fry.

Table I.—Showing the Number of Eggs and Fry dealt with and the Daily Temperature of the Water.

Date.		Number of Eggs Collected.	Number of Eggs dead in Boxes.	Number of Fry put out.	Number of Eggs and Fry in Boxes.	Temperature at noon of the Tank.		*Fry lost during Transport or Planted at Dunbar.
						Centigrade.	Fahrenheit.	
						Deg.	Deg.	
Feb.	22	60,000	...	...	60,000	4·6	40·3	...
,,	23	...	...	...	60,000	4·7	40·5	...
,,	24	170,000	...	...	230,000	4·8	40·6	...
,,	25	...	...	...	230,000	4·7	40·5	...
,,	26	180,000	...	...	410,000	4·8	40·6	...
,,	27	130,000	...	...	540,000	4·8	40·6	...
,,	28	200,000	30,000	...	710,000	5·0	41·0	...
Mar.	1	240,000	...	...	950,000	5·1	41·2	...
,,	2	400,000	...	...	1,350,000	5·2	41·4	...
,,	3	220,000	...	...	1,570,000	5·3	41·5	...
,,	4	340,000	15,000	...	1,895,000	5·5	41·9	...
,,	5	280,080	...	...	2,175,000	5·4	41·7	...
,,	6	460,000	35,000	...	2,600,000	5·5	41·9	...
,,	7	200,000	...	...	2,800,000	5·3	41·5	...
,,	8	180,000	20,000	...	2,960,000	5·2	41·4	...
,,	9	260,000	...	...	3,220,000	5·3	41·5	...
,,	10	250,000	60,000	...	3,410,000	5·4	41·7	...
,,	11	340,000	...	...	3,750,000	5·2	41·4	...
,,	12	400,000	...	...	4,150,000	5·2	41·4	...
,,	13	580,000	50,000	...	4,680,000	5·1	41·2	...

* After hatching, the eggshells sink to the bottom of the hatching boxes, from where they must at once be removed. It is not always easy to separate them from the fry, and some of the latter are therefore taken to the sea as well. The number of fry thus removed must be estimated, as there is no exact way by which the number can be ascertained. The number of fry lost in the transporting had also to be estimated, but, as they were carried in small bottles, and it generally was one or more of these that were unsuccessful, the estimation of the numbers was not very difficult.

The approximate number of fry planted locally, and of fry lost during transport, are given together in the Table.

TABLE I.—*continued.*

Date.		Number of Eggs Collected.	Number of Eggs dead in Boxes.	Number of Fry put out.	Number of Eggs and Fry in Boxes.	Temperature at noon of the Tank.		*Fry lost during Transport or Planted at Dunbar.
						Centigrade.	Fahrenheit.	
						Deg.	Deg.	
Mar.	14	120,000	...	...	4,800,000	5·0	41·0	...
"	15	210,000	25,000	...	4,985,000	4·9	40·8	...
"	16	670,000	...	...	5,655,000	5·0	41·0	...
"	17	340,000	45,000	...	5,950,000	5·1	41·2	...
"	18	700,000	...	...	6,650,000	5·2	41·4	...
"	19	800,000	70,000	...	7,380,000	5·4	41·7	...
"	20	1,000,000	40,000	...	8,340,000	5·4	41·7	...
"	21	750,000	...	...	9,090,000	5·6	42·0	...
"	22	800,000	135,000	...	9,755,000	5·8	42·4	...
"	23	440,000	...	...	10,195,000	6·0	42·8	...
"	24	560,000	120,000	...	10,635,000	6·4	43·5	...
"	25	1,000,000	...	...	11,635,000	6·5	43·7	...
"	26	300,000	80,000	...	11,855,000	6·4	43·5	...
"	27	1,050,000	...	...	12,905,000	6·4	43·5	...
"	28	500,000	35,000	...	13,370,000	6·1	43·0	...
"	29	700,000	55,000	...	14,015,000	5·6	42·0	...
"	30	300,000	20,000	...	14,295,000	5·3	41·5	...
"	31	740,000	...	...	15,035,000	5·2	41·4	...
April	1	460,000	...	2,400,000	12,695,000	5·0	41·0	400,000
"	2	350,000	180,000	...	12,865,000	5·1	41·2	...
"	3	850,000	...	...	13,715,000	5·0	41·0	...
"	4	1,200,000	55,000	...	14,860,000	5·0	41·0	...
"	5	...	...	...	14,860,000	4·9	40·8	...
"	6	820,000	...	...	15,680,000	5·0	41·0	...
"	7	580,000	...	...	16,260,000	5·4	41·7	...
"	8	800,000	45,000	...	17,015,000	5·5	41·9	...
"	9	830,000	...	...	17,845,000	5·8	42·4	...
"	10	470,000	160,000	3,200,000	14,595,000	5·6	42·0	360,000
"	11	550,000	...	...	15,145,000	6·0	42·8	...
"	12	...	130,000	...	15,015,000	6·1	43·0	...
"	13	700,000	...	...	15,715,000	6·1	43·0	...
"	14	800,000	...	...	16,515,000	6·2	43·2	...
"	15	1,200,000	110,000	...	17,605,000	5·7	42·2	...
"	16	300,000	...	4,000,000	13,245,000	6·0	42·8	660,000
"	17	350,000	...	...	13,595,000	6·0	42·8	...
"	18	..	130,000	...	13,465,000	6·1	43·0	...
"	19	750,000	...	...	14,215,000	6·4	43·5	...
"	20	...	...	...	14,215,000	6·5	43·7	...
"	21	700,000	40,000	...	14,875,000	6·4	43·5	...
"	22	600,000	...	...	15,475,000	6·6	43·9	...
"	23	...	170,000	3,300,000	11,405,000	6·4	43·5	600,000
"	24	800,000	...	...	12,205,000	6·6	43·9	...
"	25	...	...	...	12,205,000	6·5	43·7	...
"	26	660,000	200,000	...	12,665,000	6·7	44·0	...
"	27	...	...	...	12,665,000	6·8	44·2	...
"	28	440,000	...	...	13,105,000	7·0	44·6	...
"	29	...	...	...	13,105,000	7·1	44·8	...
"	30	...	20,000	2,500,000	10,135,000	7·2	45·0	450,000
May	1	...	...	...	10,135,000	7·1	44·8	...
"	2	...	...	...	10,135,000	7·5	45·5	...
"	3	530,000	...	...	10,665,000	7·3	45·1	...
"	4	...	...	...	10,665,000	7·4	45·3	...
"	5	...	...	2,100,000	8,205,000	7·7	45·9	360,000
"	6	270,000	25,000	...	8,450,000	7·5	45·5	...
"	7	...	...	3,200,000	4,700,000	7·4	45·3	550,000
"	8	60,000	75,000	...	4,685,000	7·3	45·1	...
"	9	...	...	...	4,685,000	7·4	45·3	...
"	10	...	...	...	4,485,000	7·5	45·5	...
"	11	20,000	...	...	4,505,000	7·8	46·0	...
"	12	...	...	...	4,505,000	7·6	45·7	...
"	13	...	80,000	2,400,000	1,485,000	7·5	45·5	540,000
"	14	...	...	...	1,485,000	7·7	45·9	...
"	15	...	...	...	1,485,000	7·8	46·0	...
"	16	...	...	...	1,485,000	7·7	45·9	...
"	17	...	...	...	1,485,000	7·8	46·0	...
"	18	...	...	...	1,485,000	7·9	46·2	...
"	19	...	...	...	1,485,000	8·2	46·8	...
"	20	...	...	...	1,485,000	8·4	47·1	...
"	21	...	...	...	1,485,000	8·3	46·9	...
"	22	...	...	...	1,485,000	8·5	47·3	...
"	23	...	...	...	1,485,000	8·6	47·5	...
"	24	...	235,000	1,270,000	...	8·6	47·5	180,000
		30,960,000	2,490,000	24,370,000	...	...	...	4,100,000

TABLE II., showing Localities and Physical Conditions where the Fry were Distributed.

Date.	Locality.	Time.	Temperature of the Surface Water.	Specific Gravity of the Surface Water.	State of the Tide.	Wind.	Number of Fry put out.
1897.		P.M.	Deg. C.				
April 1	Loch Fyne ; between Loch Gair and Minard Castle, . .	7.20	8·7	1024·5 6·8° C.	1¾ hrs. Flood.	E.N.E. Force 5.	2,400,000
,, 10	Loch Fyne ; between Otter Spit and Loch Gair, . .	10.0	.	.	Near Low Water.	.	3,200,000
,, 16	Loch Fyne ; off Strachur, .	8.0	.	.	Low Water.	.	4,000,000
,, 23	Loch Fyne ; between Loch Gair and Minard Castle, . .	8.30	7·8	1025·2 8·0° C.	4½ hrs. Ebb.	N. Force 7.	3,300,000
,, 30	Loch Fyne ; off Loch Gair, .	9.25	7·5	1026·1 7·5° C.	3½ hrs. Flood.	N. Force 4.	2,500,000
May 5	Loch Fyne ; between Loch Gair and Minard Castle, . .	8.35	7.2	1026·3 7·1° C.	¾ hr. Flood.	N.W. Force 3.	2,100,000
,, 7	The Clyde ; off Greenock, .	11.0	.	.	.	.	3,200,000
,, 13	Loch Fyne ; off Penmore,. .	11.15	8.5	1025·2 8·3° C.	3½ hrs. Ebb.	Calm.	2,400,000
,, 24	Loch Fyne ; off Crarae, . .	10.35	10·5	1026·0 10·8° C.	3½ hrs. Ebb.	Calm.	1,270,000
							24,370,000

In my earlier Reports on the operations at the Hatchery I have repeatedly referred to difficulties that have been experienced in connection with the spawning fishes, and also how the success of the work was thus interfered with. The source and nature of these difficulties have also been referred to in detail. The principal want in this respect is a tidal pond or reservoir in which the adult fishes could be kept comfortably from the one season to another.

With regard to plaice, I am in a position to state (1) that the death-rate amongst the fishes in the pond would be very low when a healthy stock had once been secured ; (2) that a healthy stock of fish would develop eggs normally ; (3) that all eggs would become impregnated in due course, and thus be rendered fit for development ; (4) that the present number of fry produced annually would be much increased ; and (5) that the working expenses under otherwise similar conditions would be less than at present. Without mentioning figures, I shall also state that the capital expenditure in connection with the construction of such a pond would be covered in two, or in the most three, years with what was saved by the improved arrangements. From this it will be seen that the desired completion of the station offers advantages in all respects, financially and otherwise. The problem of artificial sea-fish culture has lately become of the greatest importance, and its merits have been much discussed. But to decide a question of this nature by theoretical arguments only will hardly be found satisfying nor accepted as a final decision, however well founded it may appear. It has been found generally, and also in this particular case, that mere theory often has had to give way to the light of practical experiences and those thereon established facts. It was in recognition hereof that sea-fish hatching was taken up in this country, and it must therefore necessarily be judged on its own merits; but in order to do so the work must be subjected to a just trial and enjoy a fair chance. The fry produced in the Hatchery is at present being distributed in a relatively closed area of the sea in order to find out what effect the artificial fish culture may have upon the abundance of fish there. But owing to the incomplete condition of the station, this experiment has had to be confined to one single place (Loch Fyne), while it ought to be extended to several lochs or closed areas before the experiment can be considered a true test of the work. This is clearly so, because permanent or temporary physical conditions in any one particular place may be unsuitable for the development of an increased stock of fish, and this would perhaps only be found out by comparison with the results obtained in the various places. But such a conclusive test of fish-hatching in the present case can only be carried out when the number of fry produced is increased; and as this can be accomplished without an increased working expenditure, I hope that the proposal for these necessary improvements in the near future will be given a favourable consideration.

4. Preliminary Notes on Continued Rearing Experiments with Larval and Post-Larval Plaice and Lemon Sole.

In a paper "*On the rearing of the larval and post-larval stages of the plaice and other flat fishes*," published in last year's Report,* I described an experiment in the rearing of plaice through the post-larval stage, at the end of which the young fishes had the form and habits of the adult. In that paper it was mentioned that the greater number of the young fry which were placed in the hatching jars did not take any food, though such was present in abundance, but died from starvation. Others, again, took the food regularly and developed quickly. In referring to this peculiar circumstance I then made the suggestion that the fry might have been retained rather long in the hatching apparatus without food. In similar experiments which were carried out in the spring, 1897, the same peculiarity occurred. Some larvæ were successfully carried through the post-larval stage, but the greater number was lost in the same way as on the first occasion.

In all these experiments I had been acting upon the general belief that the larval plaice is nourished by the yolk only until this is absorbed, and at that stage I had placed them in the rearing jars and supplied the food.

By watching the process of the absorption of the yolk from the moment of hatching onwards I observed that the diminishing of the yolk appeared proportionately greatest soon after hatching, or that the amount of yolk absorbed daily was far greater in the beginning of the larval stage than later. I particularly noticed that the last portion (about one quarter of the total mass of yolk) was only reduced very slowly. If the rate of development of the plaice is reduced towards the end of the larval stage, it is probable that less nourishment will suffice; but if this is not so, it becomes evident that more nourishment is required, and possibly of a different nature, than what is simply provided by nature directly and attached to the fish in the form of yolk. It would undoubtedly be wrong to reason that the last remnant of yolk was absorbed before the first

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*Fifteenth Ann. Rep. of the Fishery Board, Part iii., page 175.

"bite" of food was taken. The two ways of nourishing are more likely to intermix—that a certain amount of food is eaten while yolk is still present. And if this is the natural process in regard to young plaice, it is not surprising that early feeding cannot successfully be dispensed with.

With the view of finding out whether the larval plaice would take any food before the absorption of the yolk was completed, I placed some newly-hatched fry in a rearing jar early in May, and added to the water tow-net collections containing samples of the ordinary plankton on this coast. When between three and four days old about the half bulk of the yolk had been absorbed, and the mid-gut had by this time begun to form the sling; this, however, was not nearly completed. *At this stage the larvæ began to take food.* The nature of the latter was much the same as I have found to constitute the food in the early post-larval stage. Small larval molluscs and larval crustaceans were observed in the stomach, though most frequently forms of infusoria (*ceretium* sp.) were observed, and sometimes diatoms. In one specimen which was three days old, and the mid-gut yet quite straight, I found four specimens of ceretium. The fact that the larvæ did take food regularly at this early stage makes it very probable that it is natural to them and that they will do so in the open sea generally. Though it does not seem to be an absolute condition for successful development (compare the rearing experiment carried out in 1896), there is reason to believe that the percentage of surviving individuals will be much increased by an early feeding. Some further experiments may illustrate this more graphically. When transporting plaice fry long distances in 1896 I found that best results were always obtained with those that still had the greater part of the yolk mass unabsorbed. Any relation between this experience and the above-mentioned peculiarity tends to show that the plaice larva has a greater vital resistance in the middle than towards the end of the larval stage in cases when additional nourishment has not been supplied. This very interesting fact in connection with larval plaice has to my knowledge not previously been stated; it will probably form a point of importance in the case of artificial rearing in laboratories, where such experiments as yet have had little success.

From lemon soles, which had been delayed in their spawning, I obtained some fertilised eggs in September. After hatching, an experiment for rearing of the larvæ was arranged and food supplied in the usual way. Soon after the mouth was open they began to eat; the yolk was then nearly absorbed.* The larvæ took food abundantly, but did not seem to thrive on it.

Tow-net collections were obtained from various places in the locality and were taken near the surface and at greater depths, but the food thus supplied did not seem to agree with them, although it was eaten of freely. Some of the larvæ were kept for ten days after the yolk had been absorbed; this was in the beginning of October, and it must be remembered that June and July is the usual time for the development of the lemon sole larvæ. Seasonal changes in the plankton on the coast would probably be of adverse influence in this case. As I hope some time later to have an occasion to continue these experiments with the lemon sole under more favourable circumstances, I shall not now give a detailed account of the observations made regarding the food and general development during the relatively short period of the post-larval stage in which the larvæ lived.

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* After this the lemon sole does not take additional nourishment at such an early stage as the plaice.

VIII.—The POST-LARVAL Stages of the PLAICE, DAB, FLOUNDER, LONG ROUGH DAB, and LEMON DAB.

By HARRY M. KYLE, M.A., B.Sc., Science Scholar, Gatty Marine Laboratory, University of St. Andrews. (Plates X., XI.)

DURING the last ten years an enormous amount of work has been done by scientific investigators* in connection with the life-histories of the important food-fishes, and of these the plaice has received the greatest amount of attention. The life-histories have been approached from two directions. The fertilised eggs have been obtained and kept in tanks until the larvæ hatched, and thus the distinctive characteristics of the larval forms made out. The larvæ of the plaice is distinguished by its large size when hatched, but the larvæ of the other four flat-fishes named are hatched at nearly the same size, the size of the newly hatched larva being related to the amount of yolk contained in the egg. Amid slight differences of description there is common agreement amongst observers that the essential distinctions between these larval forms are to be seen in the distribution and colour of the pigment. If the yolk-sac is still attached, the larvæ of the lemon dab can be distinguished from those of the long rough dab, and both from those of the dab and the flounder, by their slightly greater length. But if the yolk is absorbed and pigment is absent, as in spirit specimens, the separation of the young post-larvæ is extremely difficult, depending on some minute differences in the configuration of the head. Beyond this very early post-larval stage four of these forms have not been traced as yet, but recently the young plaice have been reared through the larval and post-larval stages to the assumption of the adult characteristics.

The other side from which the life-histories of these forms have been approached has been from their pelagic stages and conditions. It has been gradually discovered that in each life-history there is a definite cycle of migration. The long rough dab and lemon dab are deep-water fish, living at depths of twenty fathoms and more, but their eggs and larvæ are found within three miles of the shore. The plaice, in its adult mature condition, also frequents deep water, visiting certain spawning areas in the beginning of each year, and from these areas the eggs and larvæ drift in towards the shore. Its young stages, during the assumption of the adult characteristics, are found in rock-pools and brackish water. The migrations of the dab are not so extensive. It spawns within three miles of the land, although mostly at greater distances. Its larvæ and young forms are found within a few hundred yards of the shore. The flounder, again, passes the greater part of its life in fresh water, entering the streams at a very early stage and leaving them only to spawn in the sea. The drifting shorewards of these eggs, larvæ, and post-larvæ have been connected with the currents which flow southward during the greater part of the year along the coast of Aberdeenshire and Forfarshire into St. Andrews Bay and the Firth of Forth.

The eggs of four of these forms, the commonest of the pleuronectidæ, along with those of many others, are found together during certain months of the year, especially March, April, and May. The larvæ also are found together, and these are separated from the larvæ of the round fishes by "the proportionally larger eyes of the round fish, the structure of the tail, and the depression of the snout between the eyes" of the young pleuronectidæ. But the larval and post-larval forms of the flat-fish, with the exception of one or two well-marked stages in certain forms, such as the lemon dab, have hitherto been simply classed together as pleuronectids in the reports of the trawlings of the *Garland;* it was so difficult to distinguish the one from the other. Most of the specimens collected by the *Garland's* officers, as well as those taken in St. Andrews Bay and in the rock-pools, have been slowly accumulating during the last thirteen years under the supervision of Professor M'Intosh.

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* M'Intosh and Prince, "Researches," Trans. R.S.E., Vol. xxxv., Part ii., 1890; Trawling Report, 1885; and papers in "Reports of Scottish Fishery Board."

J. T. Cunningham, Trans. R.S.E., Vol. xxxiii., Part i. (1887), and Papers in the "Journal of the Marine Biological Association."

E. W. Holt, Sc. Trans. R.S.D., Vols. iv. and v. (Sec. ii.), 1891 and 1893.

C. G. Petersen, "Report of the Danish Biol. Sta.," 1893.

T. W. Fulton, "Reports of Scottish Fishery Board."

The presence of young flat-fish at the tidal margins has long been known. In the "Researches," Professor M'Intosh considered that the more completely metamorphosed specimens, about 14mm. in length, were flounders, while the thinner, more transparent, and less metamorphosed specimens at the same size might be plaice. Later,* when the flounder had become better known, and its characteristics at that size distinguished, he thought that these might be either plaice or dab.

In the "Researches" also, Professor M'Intosh included under the long rough dab certain specimens from 5mm. to 14mm. long, but without giving drawings or detailed descriptions.

In "A Treatise on the Common Sole" (1890) Mr. Cunningham gives two drawings of the flounder in its transformation stages, and in the "Journal of the Marine Biological Association" † he narrates that he had obtained young plaice, dabs, and flounders, but does not give their characteristics or distinguish them in their early stages from 10 to 15 mm. The pelagic forms—when the young flat-fish are in their post-larval or transformation stages—have been obtained and described by several observers.

Dr. Petersen, in the "Report of the Danish Biological Station" (1893), gave a brief outline of the young flat-fish of Danish waters. Without going into detail he clearly marked off the relative positions of the plaice, dab, and flounder, stating the sizes at which each completed metamorphosis. These were—about 8 mm. for the flounder, 10 to 11 mm. for the plaice, and 12 to 13mm. for the dab. Between "12 to 13 mm. the plaice is very like the common dab," but "is distinguished from the latter by its small eyes (the diameter of the apple of the eye is only half the length of that in the average-sized common dab) and by a different pigmenting." He gives a drawing of a young pelagic stage of the long rough dab, which seems to have been about 18 to 20 mm. long, and states the characteristics—"particularly projecting stomach region, and the concave profile of their heads."

Mr. Holt, in his report on the Irish survey (*loc. cit.*), minutely describes the characteristics of certain specimens considered to be plaice, dab, and long rough dab. A complete series of the plaice was obtained, and he gives drawings of five specimens from 10mm. to 21mm. The specimens of the dab were from 12·25mm. to 16mm., but none below 12·25mm. were obtained, nor from 16mm. to the stage when the adult characteristics are assumed. It was therefore by a process of elimination—comparing the specimens with those of the plaice on the one hand and those of the long rough dab on the other—that these forms were called dabs. The general differences between the plaice and the dab are:—

At the same total length (1) the rotation of the eyes is less complete in the dab than in the plaice.

(2) The height of the body is relatively greater [in the plaice than in the dab.

(3) The size of the eye, as compared with that of the head, is larger in the dab than in the plaice.

(4) A general pigmentation of the ocular side is assumed by the young plaice at a smaller size than in the case of the young dab.

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* Loc. cit.

† Loc. cit.

Nine specimens of the long rough dab are figured, ranged into an elongated and a shorter series, as it was found impossible to arrange the specimens into a single regular series. They extend from 9·37mm. to 14·77mm. The two larger specimens, 13·87mm. and 14·77mm., are shown to be remarkably like dabs, the proportions being similar. So far as the drawings show, also, the mouth is very slightly different from that of the dab. The asymmetry of the head is more advanced in the common dab, and also the pigmentation. Myomeral streaks are present in the long rough but absent in the common dab. The number of fin-rays in the long rough dab is greater than in the common dab, though at these early stages the difference is not great.

The smaller specimens are divided into two series—in the one the eye has not begun to migrate, in the other it has just commenced; but the difference is extremely slight: another difference of more importance being the greater breadth of those which are further advanced. In the absence of later specimens over 15mm. there was great difficulty in seeing the relations between these smaller series and the larger specimens of 13·87mm. and 14·77mm. Mr. Holt makes a reference also to the specimens mentioned in the "Researches" as long rough dabs. While working up his material at St. Andrews he had evidently seen these specimens, and noted that they exhibited "a depression between the eyes" and a "preponderance of pigment along the ventral line."

Later specimens, from 27mm. onwards, were also obtained by him. There was no doubt that these were long rough dabs, the characteristics being sufficiently obvious even in the smallest at 27mm. All these specimens were taken in very deep water, the smaller, metamorphosing examples, being obtained from 30 to 32 fathoms, the larger, with adult characteristics, from 40 to 80 fathoms.

The difficulties Mr. Holt had to encounter arose from the lack of complete series. He was thus compelled to trust to differences in measurements—proportions of breadth to length, head to length, &c.; but where variations are considerable, measurements are not altogether trustworthy, unless one knows the limits of variation. Indeed, Mr. Holt was quite nonplussed with the amount of variation in the long rough dab.

Mr. Cunningham, in "Marketable Marine Fishes" (1896), criticises Holt's work. He is of the opinion that the long rough dabs of Holt are, the longer specimens plaice, the smaller dabs. He seems to think, too, that the metamorphosis of the dab is completed at an earlier stage than that of the plaice, for he says (p. 225):—"Considering that when first hatched the larva of the dab is little more than half the length of that of the plaice, it is singular that it should be longer than the plaice during the process of transformation."

On p. 218 he gives a drawing of the "Larva of Plaice," a little over 15mm. long, with its eye on the ridge. Comparing this drawing with those by Holt, it evidently corresponds either with the dab or the long rough dab. Mr. Holt's specimens were in spirit, Mr. Cunningham's alive. With regard to the long rough dab, Mr. Cunningham thinks that the young forms have not yet been identified.

Dr. Ehrenbaum,* more recently, has described and figured the young larval forms of these species. A number of the young post-larval stages of the plaice were obtained by trawl-net, and the characteristics of this species, from the larval stage to the assumption of the adult characteristics, are placed in tabular form. He describes also the early post-larval stages of the flounder. The post-larval stages of the dab were not obtained, however, nor those of the long rough dab and lemon dab.

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* Eier u. Larven von Fischen der Deutschen Bucht. Wissen, Meere, 1896.

The Fifteenth Annual Report of the Scottish Fishery Board (1897) contains the results of Mr. Dannevig's experiments on the rearing of the young plaice. He gives the measurements of its length and breadth at the various stages, with an account of its food. The life-histories of these forms are described in "British Marine Food-Fishes,"* so far as they are known. Coloured drawings show several stages in the developmenta of each. With regard to the separation of the plaice and the dab Holt's conclusions are accepted.

THE PLAICE AND THE DAB.

Being, therefore, in the light of recent research, in a more favourable position than Mr. Holt was, these pages contain the results of observations upon the specimens in Professor M'Intosh's collection.

It was thought that if a series of specimens of each species could be obtained, showing the gradual passing of the larval characteristics into the post-larval, and these into the adult, the separation would be effected. From the collection of Professor M'Intosh, however, half-a-dozen complete series of the plaice and the dab might be obtained with certain portions always the same but other portions different. The variations in the characteristics of these two forms are very great, overlapping at various points during development, so that the notion of a complete series is rather misleading. All that could be done was to separate the portions that were clearly distinct, and then use a calculus of probabilities, as it were, to separate the remainder.

The flounder is separated from these two forms, chiefly because it undergoes metamorphosis at a smaller size than they do, and because the variations in the number of its fin-rays do not overlap those of the plaice and the dab.

Recent research, by Petersen in Denmark, Duncker† at Kiel, Cunningham on the east coast of England, and Holt for the west coast of Ireland, has shown that the number of fin-rays of these species is much more variable than was formerly thought, the variations being different in different regions. Yet, as a rule, the flounder is distinguished by its smaller number of fin-rays. The long rough dab and the lemon dab, on the other hand, have a larger number of fin-rays than the plaice and the dab, though the peculiar manner of growth of the fin-rays in the young stages of the long rough dab causes overlapping with the plaice and the dab at these stages. The plaice and the dab, however, overlap at all stages, and this character is not a distinguishing one. After separating the long rough dab, the flounder, and the lemon dab specimens by means of this fin-ray formula, and other characteristics to be mentioned later, a large number of plaice and dab remained.

These were separated, roughly at first, in various ways. A number of specimens, for example, formed a series from 5 mm. to 12 mm., showing the transition from the earliest, with caudal fin-rays developing, to the latest, with the left eye beginning migration. Such a series occurred in several bottles, and were evidently of the same species—dabs. A number of specimens of the larval plaice, from 6 to 7 mm., and early post-larval at 8mm., are present, and these are not to be mistaken for any other form—certainly not the dab.

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* **British Marine Food Fishes. M'Intosh and Masterman, 1897.**

† **Var. u. Verwand, r. *Pl. flesus*, u. *Pl. flesus*. Wissen, Meere, 1896.**

Between 8·5 and 10 mm. it was found that the specimens considered to be dabs at that size might fit into a series leading to specimens at 10mm. and onwards, which for various reasons were considered to be plaice.

Other specimens could be found to fill the gap, but there was very little difference between them all. Those which might be considered plaice were, if anything, a little thinner and flatter in the body, whereas the dabs were rounder; but such difference as there was would easily have been explained away as due to individual variation.

The lines of development of the plaice and the dab were therefore considered to cross between 9 and 9·5 mm. Between 10 and 12 mm. the dabs were clearly marked off from a great number of specimens which were in process of metamorphosis. But these dabs did not fit into a series with those of Mr. Holt, nor could his be separated from what was thought to be plaice. Relying upon measurements of eye and head, breadth and length, he had separated specimens at the same length and the same stage of metamorphosis. His figures 109, which represents a plaice, and 112, a dab, correspond so far as metamorphosis is concerned, the eye being half-way. In fig. 112 the dorsal fin is not continued forward to the eye, but this may have been due to accident. Such a gap between dorsal fin and eye was not seen in any of the specimens in the collection.

The differences in proportions are not great. In the plaice the length (without tail) is 2¼ times the breadth (without fins), in the dab it is 3⅓ times; in the plaice the length is 3⅓ times the length of the head, in the dab it is 4 times. Mr. Holt lays stress on another proportion, namely, eye to head. But this measurement is of no use, it seems to me, because the eye is more subject to unequal contraction than the head, and the iris (which was taken as the measure) is not round. The proportion of eye to head in the plaice at these stages was found to vary from $\frac{2}{9}$ to $\frac{1}{3}$.

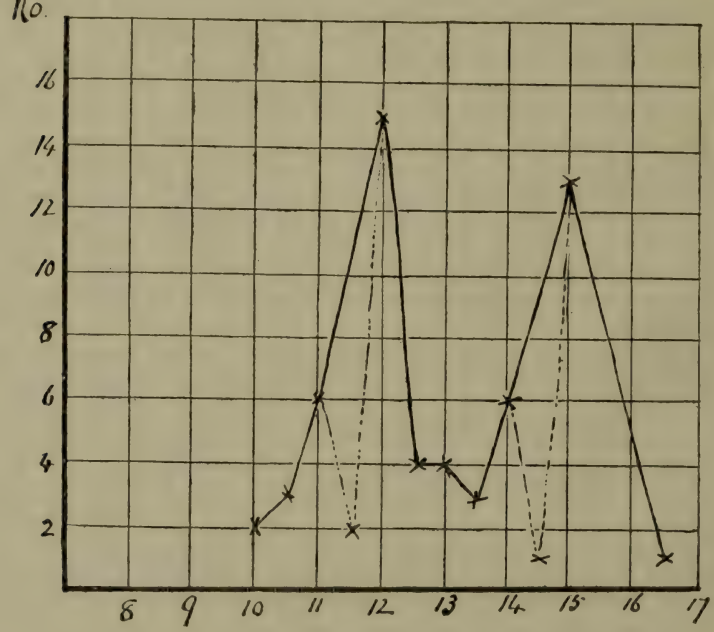
Another difference, the length at which pigment is assumed, is also variable. In the plaice, it depends upon when they take to the bottom, and the length at which this occurs is known to be variable.

Mr. Holt's figures 110 and 113 correspond also, so far as the stage of metamorphosis is concerned, and both seem to be plaice. On the other hand, fig. 114, length 14·5mm., is in a stage corresponding with fig. 109 of the plaice, length 12·25mm., the eye being half-way, and seems to be a dab.

The lines of development of the plaice and the dab are certainly very close, but not so close as Mr. Holt thought. With such a large number of specimens the investigation at this stage became a study of variations. The first point was to trace out the probable lines of development, and for this there were several aids. The plaice was known to be completely metamorphosed at 14mm. to 16mm., and a number of specimens at such a stage were present in the collection. On the other hand, there were no completely metamorphosed specimens of the dab below 17mm. From the series of dabs already referred to it was evident that the dab underwent metamorphosis at a greater length than the plaice. The lateral line, also, is present in the plaice much sooner than in the dab. The next point was to determine when metamorphosis is half complete, *i.e.*, when the pupil of the left eye is in a line with the dorsal fin.

Sixty-two specimens were counted out at this stage, and their lengths measured. There was a difficulty with some of the specimens, because the fin curves as it approaches the left eye, bending round its posterior left-hand margin. This occurred in the smaller specimens, the plaice. In the larger specimens, the dab, the dorsal fin overhangs the left eye at this stage (figs 10, 11; and fig. 114, Holt), but I am not certain how far the difference is of specific value. This condition, the dorsal fin overhanging the eye, is present in the lemon dab, perhaps also in the long rough dab. When the bending occurred (due to the twisting of the forepart of the skull) the eye was considered half-way, when the pupil was in a line with the fin a little distance from the eye.

The following curve represents the result:—



There are several considerations that prevent me from thinking this curve accurate, but since it fairly well represents the tendency of the rest of the specimens to fall into two groups, as well as the point where they overlap one another, it is quite definite. The lower is taken to represent the plaice, with a maximum for this stage at 12mm.; the higher group, the dab, with a maximum at 15mm. Between 13mm. to 13·5mm. is the position where there is difficulty in separating the specimens at this stage.

It might be thought that the lower group should represent the dab, the higher the plaice; but there are no specimens to support this view.

It may also be thought that the curve only represents one species, the plaice, and that the small number of specimens accounts for the minimum about 13·5mm. Apart from the fact that a series of specimens representing the upper group (figs. 1 to 13) differs in characteristics from a series representing the lower group (such as that given by Mr. Holt), from 10 to 16·5mm. is too great a variation to ascribe to one species at this stage. The presence of two species seems certain from this alone.

All specimens below 13mm., with metamorphosis half complete or more than half complete, were separated as plaice, and all above 13·5 mm., with the eye not half-way, were considered to be dabs. This separation was found to agree with the general distinctions made by Mr. Holt, viz., at any length the breadth of plaice was greater than that of dab, metamorphosis was further advanced, and for most there was more pigment on the plaice than on the dab.

The variation in length when the eye is half-way is, therefore, for the

Dab.	Plaice.
13·5 to 16·5 mm.	10 to 13·5 mm.

Dr. Ehrenbaum* gives this variation for the plaice as 13 to 14·5mm. for living specimens. Mr Dannevig† places this stage at 12·4mm. for living specimens. If from 1 to 2mm. be allowed for contraction in spirit—measurements were made to find this contraction and gave this result for specimens about this length—then my results agree partly with Ehrenbaum's, viz., from 11·5 to 14·5mm. The maximum was 12mm., which, allowing for contraction, becomes about 13mm. for living specimens, somewhat greater than the length given by Dannevig. Artificial and uniform conditions perhaps account for this last result. Dannevig does not mention any variations in length.

Measurements were also made of the breadths at this stage :—

For the Dab.	Plaice.
3 to 5 mm.	3 to 5·5 mm.

Only one specimen of the dab 16·5mm. in length reached 5mm. ; 4·5mm. was the greatest breadth for the others. The average for the dab was 3·8mm.; for the plaice 4·3mm. Dannevig gives 4·8mm. for living specimens of plaice. Lengths were measured from tip of snout to end of caudal fin-rays; breadths, across broadest part of body, excluding the median fins.

The determination of the lengths and breadths at complete metamorphosis is the next point to be considered. Some specimens below 11mm. were found with metamorphosis nearly complete—metamorphosis being considered complete when the dorsal fin was at least halfway along the border of the left eye, but these specimens were evidently much contracted. On the other hand, there were specimens at 14·5mm. with metamorphosis barely complete. These specimens were considered to be plaice from their great breadth.

The variation in spirit specimens is, therefore, from 12 to 15mm. For living specimens this would be from 13 to 16mm.

Specimens were collected from the rock-pools and the harbour during the months of May and June. The smallest completely metamorphosed was 14mm., and the largest incompletely metamorphosed was 15·5mm. From 14 to 16mm. would, therefore, represent the variation in the specimens during the past year, 1897, but 13mm. represents better the lower limit for former years. Ehrenbaum would make this variation from a little under 14mm. to 18mm. For spirit specimens the average length is between 13 and 13·5mm., which, for living specimens, means over 14mm. Dannevig gives 13·76mm. as representing the length of the specimens reared artificially.

The breadth of the plaice when metamorphosis is just complete is from 5 to 6mm.; none with breadth below 4·8mm. were found with metamorphosis complete. On the other hand, several with breadth 5·5mm. were incompletely metamorphosed. Dannevig gives 6·4mm. for living specimens. To ascertain the limits of complete metamorphosis of the dab one must reason from the spirit specimens. The smallest almost complete is 15·25mm. ; another in exactly the same phase is 18mm. Two specimens at 17mm. and18mm. have completed metamorphosis. A number of specimens at 16mm. are incomplete, and in one, 16·5mm., the eye is only half-way. The limits in spirit are therefore 15·5mm. to 18mm., and, in the living condition, from 16 to 19mm. probably.

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* Loc. cit., p. 265.

† Loc. cit., p. 187.

These were considered to be dabs; the incompletely metamorphosed because they fell within the upper of the two groups already dealt with, and because they led, by gradual steps, to dabs, with all the adult characteristics.

An important point which arose at this stage was the determination of the length at which the lateral line appeared. Mr. Holt states that there were traces of a lateral line present in a dab of 15·25mm., and in his drawing (fig. 115) represents it as extending the whole way along the body. The lateral line is not developed all at once, and there are two, if not three, successive stages in its appearance. It first appears on the tail region, from the abdomen to the caudal fin-rays, and about the same time on the head. The intermediate portion, the bend over the abdomen, is not present till much later. This is the case in the flounder, plaice, and dab. There are markings on the skin, lines clearer than the surrounding tissue, which might be mistaken for the lateral line, but closer inspection shows they are the tracings of the superficial nerves, with little resemblance to the trace of the lateral line, which looks like a string of beads. Sixteen specimens of the dab between 15mm. and 26mm. were examined. These led, by gradual steps, from the incompletely metamorphosed stages to those with lateral line complete, and in their elongated oval form, large eyes with large pupil, as well as their general pigmentation, showed the gradual assumption of characteristics of the dab. In all these specimens the tail and head portions of the lateral line were present, but only in the largest, 26mm., were there signs of the markings growing out from the head portion and tail portion to meet in the curve.

In one specimen at 24mm., and those from 26·5 onwards, the lateral line was complete; 25mm., therefore, may be taken as the average length when the lateral line is complete in the dab, though the tail portion is present at 15 to 17mm.

Dr. Petersen* states that the lateral line is complete in the dab at 20mm., but, in all stages of metamorphosis, the dab, plaice, and flounder of Danish waters are earlier (assume the characteristics at a less length) than those of British waters.

Similar examination of specimens of the plaice and flounder showed that the average length for the appearance of the complete lateral line was 18mm. for the plaice, 14-15mm. for the flounder. In the plaice the tail portion of the lateral line can be seen in some at 13·5mm., and it is complete in some between 16 and 17mm.

The breadth of the dab when metamorphosis is complete was determined as nearly as possible. At 15·25mm., metamorphosis hardly complete, the breadth was 4mm.; at 17mm., metamorphosis complete, breadth, 5·5mm.; at 18mm., metamorphosis hardly complete, breadth, 5·5mm.; at 18mm., metamorphosis complete, breadth, 6·5mm. The breadth at complete metamorphosis is therefore from 5 to 6·5mm.

At these stages, when the adult characteristics are gradually being assumed by the plaice and dab, Dr. Petersen gives the size of the pupil of the eye as a guide, the pupil in the dab being twice the size of that in the plaice. Measurements were made of the pupil at different lengths, with the following results:—

	Dab.	Plaice.
At 14 mm.	·3 mm.	·3 mm.
15 ,,	·5 ,,	·35 ,,
17 ,,	·7 ,,	·5 ,,
21 to 25 ,,	·9 ,,	·7 ,,

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* Loc. cit., p. 127.

Dr. Petersen's specimens may have been measured when alive, and unequal contraction may account for the approximation of these sizes; but the conclusions from these measurements are that for the pelagic stages, free-swimming, the pupil of the eye is of the same size for both, the difference being so slight as to come within the possibilities of errors in measurements, and that, when the plaice takes to the shallow waters at the tidal margin, and the dab sinks to the bottom in deeper waters, the pupil of the dab increases in size faster than does that of the plaice.

A note was also made of the number of fin-rays, though at these early stages, when the bones are not hardened, the fin-rays are most subject to injury. For this reason only a few, in comparison with the large number that had to be disregarded, could be counted. The numbers are contrasted with those given by Day* and Petersen†.

For Dab,	D. 70 to 77.	Day,	D. 65 to 78.	Petersen,	D. 65 to 73.
,,	A. 50 to 61.	,,	A. 50 to 62.	,,	A. 51 to 55.
For Plaice,	D. 68 to 77.	,,	66 to 77.	,,	61 to 80.
,,	A. 50 to 56.	,,	50 to 57.	,,	46 to 57.
For Flounder,	D. 58 to 64.	,,	60 to 62.	,,	49 to 65.
,,	A. 38 to 46.	,,	39 to 45.	,,	33 to 43.

The point worthy of note is the great variation of the flounder and plaice recorded by Dr. Petersen. D. 60 to 62 for the flounder, given by Day, does not represent the variation in the number of dorsal fin-rays.

Mr. Cunningham‡ has recently given a large enumeration of the variations in characters of plaice from different regions. The variation in fin-rays is D. 67 to 81, A. 49 to 60. The higher numbers occur more frequently in the females, and more frequently in those from the south of England than in those from the east, but the difference is slight.

The question of the distribution of pigment is the most difficult to deal with, especially from spirit specimens. Mr. Holt says that "a general pigmentation of the ocular side is assumed by the young plaice at a smaller size than in the case of the dab." Since metamorphosis is complete in the plaice earlier than in the dab, and the young plaice sink earlier to the bottom, this general pigmentation is the consequence. During the pelagic stages the distribution of pigment on the plaice and the dab is the same for the most part—a varying number of groups along the interspinous regions and on the fin-rays, along the lateral line, and detached spots over the rest of the body and on the head. This seems to be the maximum of pigment, and varies considerably. It is present on both sides, though fainter on the left, during the transformation stages. It seems, therefore, to have its origin during the symmetrical and early transformation stages.

When the pelagic stage is prolonged, as in the dab, long rough dab, and lemon dab, black pigment appears along the lines of the myomeres. Its presence is very variable, however. If pigmentation depend upon one chemical compound, and the various colours are simply the result of the presence of this compound in varying quantities—the smaller quantities giving rise to red or yellow, etc., a large quantity giving rise to black—it can be understood why black is more permanent than the others, and why what is coloured red or orange in one form is black in another. In living specimens of the early transformation and symmetrical stages one would expect to see coloured pigmentation on fin-rays and interspinous regions where afterwards the black appears. While the pigmentation of the plaice and the dab is the same during the pelagic stages, the increase of pigment in the plaice at an earlier stage is a secondary effect, due to

* Day, British Fishes.

† Loc. cit., p. 128.

‡ J. M. B. A., March, 1897.

its earlier (in length) metamorphosis and the assumption of new surroundings—it is an adaptation to life on the bottom. If, however, the pelagic stage is prolonged, as it is for many, the pigmentation is no guide. The presence of a large amount of pigment at an early stage, say 12 to 13mm., is a positive index that the specimen is a plaice, because it will accompany a greater degree of transformation; but its absence is no indication that the specimen is a dab.

The pigmentation of the young plaice when they come into inshore waters varies with the ground they are on, being a dull grey in those on muddy ground, a light yellow in those from sandy pools. The dull grey colour is also seen in the flounder. This pigmentation is due to a deposit in the epidermal cells, being general all over the body. At this time, also, the first indications of scales may be detected.

All stages, from the clear transparent forms, with the pelagic pigmentation only, to those with very dense dull grey pigment, were obtained from St. Andrews harbour during May and June. The presence of these two forms, apparently distinct so far as pigment is concerned, might lead one to think that both the dab and plaice were present. The flounder, of course, is quite distinct; but the presence of transitional forms leads to the conclusion that the clear and transparent forms are the more recent arrivals from deeper waters. Forms resembling Mr. Holt's dabs (figs. 112 and 113, l.c.) were obtained, and this first led me to suspect that his separation of these species was not the correct one.

When these specimens are examined under the lens or microscope a beautiful play of colour will be seen along the lines of the myomeres—red, orange, or yellow. If these colours are dependent on the presence of one substance in the tissues, then an increase of this substance along the lines of the myomeres will appear black, and thus the condition is arrived at which Mr. Holt considered characteristic of the long rough dab. The presence of black along the myomeres has some connection with the free-swimming pelagic stage. It does not appear to any extent in the plaice and flounder; in the dab it is present in some more than in others, depending, apparently, on surroundings. Specimens from the surface, fifteen miles from land, show it very distinctly, while it is scarcely present in the specimens taken in inshore waters; the long rough dab shows it to a marked degree, and it is also present in the lemon dab. One might almost think, therefore, that the early assumption of general pigmentation by the plaice, and the presence of the myomeral pigment in the prolonged pelagic stages of the dab, would serve to distinguish these forms, but the possibilities of pigmentation in these flat-fish, shown by Prince and Cunningham, make reasoning from pigmentation alone somewhat precarious.

The groups of pigment on the body of the dab in the pelagic stages seem to break up afterwards into a number of scattered spots (fig. 13). This is seen in those which are almost transparent, but as only spirit specimens were examined, the grouping may be present under natural conditions. At the same time, a slight yellowish brown colouration appears, corresponding to the dull grey brown of the plaice, and this later deepens into the reddish brown of the adult, though this varies with the ground the dab is above.

Summary of the Distinctions between the Plaice and the Dab.

The endeavour has been to show the limits of the variations in the young stages of these forms. It is quite possible that the variations under natural conditions may not be so great or may be greater, but since the conclusions have been based on such a large number of specimens these limits should be fairly representative. Since these results are for spirit specimens, the results of Ehrenbaum and Dannevig for living specimens have been compared with them. (1) Below 9mm. the plaice is distinguished by its proximity to the larval condition. (2) Between 9mm. and 10mm. the two forms are very much alike, the dab being, if anything, rounder in head and body. (3) Between 10mm. and 13mm. the plaice is distinguished by its earlier metamorphosis, greater breadth, and, to a certain degree, by greater amount of pigmentation. (4) Above 15mm. the plaice is distinguished by these same characteristics, and by the gradual assumption of adult features. Between 13mm. and 15mm. these distinctions hold for the majority of forms, but there are specimens in the collection about which there is some doubt, due to the late assumption of complete metamorphosis by some of the specimens of the plaice, and the early assumption of this stage by some specimens of the dab. This difficulty, which will be between 14mm. and 16mm., may not exist for living specimens, because contraction by spirit will affect the dab at this stage more than the plaice. When metamorphosis is half complete, or about this stage, there is a bend in the dorsal fin, close to the left eye, in the plaice which is not present in the dab.

Definite measurements are given in the Table of Characteristics.

LONG ROUGH DAB.

The eggs of this form occur with those of the plaice, and are common in the months of March and April, both on the east and west coast of Scotland. A large number of specimens are present in the collection, which, from their occurrence with the plaice and dab in such numbers, are most likely to be long rough dabs. In size they range from 4mm. to 21mm.; from the larval condition to when the left eye has begun its migration but is not yet half-way. These later post-larval specimens agree with the drawing of Dr. Petersen. This observer does not mention the size of the specimen, but, judging from those in the collection, it would be from 18mm. to 20mm. long, though it may have been smaller, since the other flat-fishes of Danish waters undergo metamorphosis sooner than those of British. With the exception of some doubtful damaged ones, all the specimens ascribed to this species are very distinct from those of the other species, and possess the characteristics given by Dr. Petersen —"particularly projecting stomach region and the concave profile of their heads."

The specimens described by Mr. Holt differ from these in many respects. His smaller specimens, from 8·7mm. to 12·25mm., which are divided into two series, seem to be of this species, the difference in the degree of transformation being quite within the limits of variation, which is considerable in these forms, as shown by the plaice and the dab. There are several important differences in these from those of the North Sea. As Mr. Holt remarked, the concave profile of the head is hardly evident in his specimens, nor is the projecting stomach region; development is further forward also.

What is so noticeable in the specimens from the North Sea is the peculiar manner in which the fin-rays appear. Their first appearance, between 9mm. and 10mm.—this is in agreement with Holt—is half-way along the dorsal and ventral fins. Between 10mm. and 14mm. they increase forwards to the head and backwards to the tail. This is not remarked by Holt. From 12mm. to 17mm. there is very little change in the degree of transformation, though variations are numerous, and in one or two the left eye has begun to migrate before 15mm.

The fin-rays increase from the small numbers given by Holt—D. 67-70, A. 54-58, to D. 77-82, A. 58-61.

The fact that the fin-rays are just appearing between 8mm. and 10mm. together with the elongated form, the pointed appearance of the head, the large mouth and mandible, and the amount of pigment along the myomeres, leads one to think all these figures of Holt already mentioned as of this species. The various stages in development appear sooner, however. In his shorter series, which are not so like the long rough dabs of the North Sea as the elongated series, the notochord does not project beyond the hypural structure at 9·37mm.; in the specimens from the North Sea it is seen at 16mm. in some. In the largest specimens from the North Sea, 21mm., the left eye is not yet half-way. There are no specimens later than this, but, judging from these, metamorphosis cannot be complete until nearly 30mm. Mr. Holt shows a specimen at 27mm., metamorphosis complete. Otherwise the specimens from the North Sea are in series with this specimen, the largest being 6·7mm. broad where this is 8mm.

Mr. Holt has filled up the gap between 12·25mm. and 27mm. by two specimens which closely resemble the dab of the North Sea. The distinctions between the two species at 13 to 15mm. in length are given as "the larger mouth in the long rough dab." This, however, is not so evident as in the smaller specimens at 9 to 11mm. "The asymmetry of the head is more advanced in the common dab than in the long rough dab"—but if fig. 102 (long rough dab), 13·87mm., be compared with fig. 114 (common dab), 14·5mm., there seems little ground for doubt that the two are of the one species. It was because he mistook the variations of the plaice for dabs that Mr. Holt has considered the common dab as the long rough dab. Another difference mentioned is the presence of pigment along the lines of the myomeres, but, from what has been said before, this is not altogether diagnostic, and is present in the common dab.

Fig. 103, length of specimen 14·77mm., described by Mr. Holt, had a fin-ray formula of D. 80, A. 62. This certainly is beyond the limits of the common dab, but in all other characters, breadth 4·75 to 4·87mm., length of caudal fin, 2·6 to 2·7mm., degree of metamorphosis, they are like the dabs of the North Sea. On the other hand, they are very different from the specimens of the long-rough dab. The drawings and the characteristics given in the Tables sufficiently describe the young post-larval stages of this species, so that no further explanation is needed here.

The Lemon Dab and the Flounder.

It is unnecessary to refer to the characteristics of these forms in any detail, they have been so clearly defined by the writer already quoted. The distinguishing characteristics are drawn up, from personal observations, in the following Table.

In connection with the lemon dab, it has to be mentioned that contraction, due to spirit, is very considerable during the early stages. Thus, some specimens at 9mm. in length were found to have the fin-rays developed, whereas some over 10mm. had no trace of them. Again, specimens at 16mm. had the eye half-way, and various others from that size to 25mm. were in the same stage. In all cases where contraction is great it is easily detected by the folds of the fins. This was also noticeable in many specimens of the long rough dab.

TABLE OF CHARACTERISTICS.

Length in Mm.	Plaice.	Dab.	Flounder.	Long Rough Dab.	Lemon Dab.
5	—	Tail slightly heterocercal; caudal fin-rays appearing. [Lemon-yellow pigment in longitudinal rows—two on body, one on dorsal fin.]	Tail slightly heterocercal; caudal fin-rays appearing. [Brownish yellow and black pigment in a conspicuous band across the trunk and both marginal fins, gathering later into three bands on body and edges of marginal fins].	Prominent underjaw; projecting snout.	Snout pointed, with a downward curve. [Diffuse yellow pigment, becoming concentrated to give patches, canary-yellow coloured, tinged with black; later black preponderates.]
6 to 7	Larval; broad marginal fins. [Pigment, dorsal and ventral row of black, diffuse yellow spots.]	Bending of notochord increased; caudal fin-rays increasing; fin-rays becoming differentiated, and interspinous regions marked off. [Pigment (?)].	As dab—fin broader.	Tail slightly heterocercal; caudal fin-rays appearing.	Tail symmetrical; curve on snout.
7 to 8	End of notochord bending upward; caudal fin-rays appearing.	Notochord still further bent upward; interspinous regions more clearly marked off; fin-rays more definite.	Tail becoming homocercal; fin-rays developed; pelvic fin present; eye appearing at ridge, is half-way about 8mm.; breadth, 2mm.	Do.; depression between the eyes appearing.	Do.
8 to 9·5	Tail passes through heterocercal phase; interspinous region marked off; fin-rays appear; breadth at 9·5mm., 2·2mm.	Fin-rays definite and clear; caudal rays almost full number; is like plaice; breadth at 9·5mm., 2·2mm.	Metamorphosis complete about 9·5mm.; breadth, 3·5mm.	Interspinous region becomes marked off, and later, fin-rays are differentiated in the median portions of marginal fins.	Tail becomes heterocercal; caudal fin-rays appear.
10	Left eye beginning to migrate; breadth, 2·5 to 3·2mm.	As before; breadth, 2·2 to 2·7mm.	Metamorphosis complete.	Number of fin-rays increasing; breadth, 2·5mm.	Do.
12	Eye half-way; pelvic fins present; breadth (average) 4·3mm., (variation) 3 to 5·5mm.	Pelvic fins appear; left eye beginning migration; breadth, 2·7 to 3·5mm.	—	Fin-rays almost complete; breadth, 3mm.	Marginal fin-rays become differentiated; breadth about 4mm.
14 to 6.	Metamorphosis complete; lateral line appears on tail region and on head; breadth 5 to 6·5mm.; D. 66–81, A. 49–60 (Cunningham).	Eye half-way, about 14mm. for St. Andrews Bay and Forth; about 15mm. for Moray Firth and off Aberdeen; end of notochord cannot be distinguished at 13·5mm.; breadth, 3 to 5mm.; D. 65–78, A. 50–62 (Day).	Lateral line complete; D. 58–64, A. 38–46.	Elongated tail region; projecting snout and large mouth; prominent abdominal region; eyes symmetrical; left eye begins migration about 16mm.; tip of notochord can still be seen at 16mm.; breadth, 3·6 to 4·2mm.	Tail region abruptly narrowed behind abdomen; fin-rays complete; left eye has begun to migrate; pigmentation diagnostic; breadth, 5 to 6mm.; D. 88–91, A. 70–75.
16 to 18.	Lateral line complete at 18mm.; pupil of eye, ·35 to ·5mm.	Metamorphosis complete; breadth 5 to 6·5mm; pupil of eye, ·5 to ·7mm.; lateral line present on tail region and on head.	—	Left eye begun to migrate; breadth, 4 to 5mm.	Eye approaching half-way; breadth, 7mm.
20 to 24	—	—	—	Breadth, 6 to 7mm.	Eye half-way; breadth 9mm.
25	—	Lateral line complete.	—	[Eye past half-way.] Metamorphosis almost complete at 27 mm.; breadth, 8mm.; marginal fins reach only to base of caudal peduncle; D. 76–87, A. 60–69 (Day).	Eye still on ridge at 27mm., but past half-way; breadth, 11mm.; marginal fins reach to extreme end of body; D. 85–93, A. 70–76 (Day).

DATA OF COLLECTION, DISTRIBUTION, &c.

A large number of specimens were omitted from these data, either because they were doubtful or belonged to other species. The doubtful specimens were mostly in the early post-larval stage, from 3mm. to 6mm. Sufficient remain, however, to illustrate the main facts of distribution. The distribution of these post-larval forms is connected, on the one hand, with the spawning areas of the adults and the distribution of the eggs; on the other hand, with the migrations and distribution of the immature fish.

Dr. Fulton,* in the 15th Annual Report of the Scottish Fishery Board, has described the results of the experiments on currents which were carried on for some years on the east coast of Scotland. In this paper (p. 334) he shows that the distribution of the eggs, larval and early post-larval stages, is due to the existence of currents, tending in the main, and for the greater part of the year, in a southerly direction along the east coast of Scotland. These are surface currents, probably extending down to at least 6 or 7 fathoms, but it is quite possible that the whole depth of the water has a similar movement. Certain influences cause variations at particular places and seasons. "In confined areas, like the western part of the Moray Firth and the Firth of Forth, the movement of the surface water is irregular, and depends upon variations in the winds and tides."

The distance over which the eggs will drift depends upon the length of time the young embryo is in the egg, other things being equal, and the time taken to pass through the larval and early post-larval stages. Only for one form, the plaice, has this period been determined; and Dr. Fulton, reasoning from this, thinks that the eggs of the plaice may travel 50 miles or more, and that the young plaice found on the sandy beaches may be from 60 to 100 miles from the spawning ground of the adults.

In the same number of the Reports, Professor Cleve†, of Upsala, gives a short sketch of a theory on the distribution of currents. These currents are characterised by different marine organisms, crustaceans, diatoms, flagellates, etc.

The importance of this theory lies in the aid it gives to the understanding of what becomes of the post-larval stages. If the eggs and early post-larval stages are subject to drift, the late post-larval stages are admitted by Dr. Fulton to be able to look after themselves. When these young forms come into inshore waters it is found, as will be shown by the data, that there is a complete separation of these species from one another. These currents may have something to do with this separation, in addition to the inherited tendencies in the different species to seek different habitats and different food.

PLAICE.

Date.	Net.	Place.	Number of Specimens.	Length in mm.
April 3, 1893	Midwater	East of May, ...	1	12
,, 16, 1887	,,	St Andrews, ...	1	12
,, 17, 1895	,,	Station I., Forth, ...	2	12, 12·5
,, 23, 1888	,,	St Andrews, ...	8	Larval.
,, 26, 1889	,,	,, ...	1	Larval.
,, 28, 1887	,,	,, 4 fathoms, ...	2	10, 10·5
,, 19, 1895	Bottom	,, ...	1	8·5
,, 25, 1890	,,	Station VII., Forth, ...	1	9

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* The Currents of the North Sea, etc., p. 334.

† Report on the Phyto-Plankton, etc., p. 297.

PLAICE—*continued.*

Date.	Net.	Place.	Number of Specimens	Length in mm.
May 1, 1890	Surface	Station V., St Andrews,	1	11
,, 2, 1890	,,	Station I., ,,	2	10·5, 11
,, 7, 1890	,,	Forth,	4	13 to 14
,, 8, 1890	,,	St Andrews,	4	12 to 14
,, 10, 1893	,,	,,	1	10
,, 13, 1893	,,	,,	2	11·5, 13
,, 20, 1890	,,	Station I., Aberdeen,	4	10·5, 12·5
,, 22, 1894	,,	Between Montrose and Aberdeen,	5	13
,, 27, 1891	,,	Station III., Forth,	2	9, 11
,, 27, 1894	,,	Cross-section II., south half, Aberdeen,	1	10·5
,, 28, 1891	,,	Station V., Section II.	1	10
,, 3, 1890	Midwater	East of Inchkeith, Forth,	2	6·5
,, 7, 1892	,,	Liston Bank,	5	6 to 11
,, 10, 1888	,,	St Andrews,	1	11
,, 11, 1891	,,	4 miles east of May Island, 10 fathoms,	1	9·5
,, 26, 1892	,,	West of Liston Bank,	2	8, 10
,, 28, 1892	,,	St Andrews,	2	10·5, 12
,, 31, 1892	,,	Cross-section III., Forth,	1	8
,, 1, 1890	Bottom	Station V., St Andrews,	2	11
,, 1, 1890	,,	Stations IV. and III., ,,	4	6
,, 2, 1893	,,	Station IV., Moray Firth,	33	6 to 10·5
,, 2, 1893	,,	Station V., ,,	40	Early post-larval; other forms present
,, 3, 1893	,,	Station II., ,,	9	6·5 to 11·5
,, 17, 1892	,,	Station VII., Forth,	3	8·5 to 9·5
,, 20, 1890	,,	Stations I. and II., Aberdeen,	6	10 to 11
,, 21, 1895	,,	Stations I. and IV., Forth,	4	8 to 10
,, 22, 1891	,,	Aberlady Bay,	4	8 to 9
,, 24, 1892	,,	Station 0, Forth,	1	9
,, 26, 1890	,,	Cromarty Firth,	2	8, 9
,, 27, 1890	,,	Station IV., Moray Firth,	3	12 to 12·5
,, 13, 1897 ,, 22, 1897	,,	Harbour, burn, etc.,	Large number	13 to 20
	,,	Eden,	...	12 to 27
June 1, 1892	Surface	Between Hirwit and Rost, Forth,	2	10, 12
,, 2, 1893	,,	Station IX., Forth,	1	12·5
,, 6, 1895	,,	Station IV., St Andrews,	1	10·5
,, 7-8, 1888	,,	St Andrews,	15	10 to 13·5
,, 8, 1891	,,	Station I., Forth,	12	8 to 12
,, 13, 1892	,,	Station V., Forth,	1	11
,, 9, 1891	Midwater	Round Island of May, 6 to 8 fathoms,	4	8 to 12·5
,, 15, 1892	,,	Station VII., Forth,	1	9
,, 28, 1887	,,	In Harbour,	1	10
,, 1, 1889	Bottom	St Andrews,	3	11 to 12
,, 7, 1888	,,	,,	10	13 to 13·5
,, 8, 1888	,,	,,	5	10 to 12
,, 8, 1887	,,	Kinness Burn, in brackish water,	10	15 to 17
	,,	Rock-pools,	Large number	13 to 27
,, 2, 1897 ,, 12, 1897	,,	Harbour,	,,	13 to 22
July 8, 1891	Surface	Largo Bay,	1	11·5
,, 9, 1891	,,	Station V., Forth,	1	10
,, 5, 1888	Bottom	St Andrews,	2	12, 12·5
Aug. 4, 1891	Midwater	Elie to Crail,	4	6 to 8
,, 9, 1888	,,	Bell Rock,	4	9 to 10
,, 26, 1888	,,	St Andrews Bay,	6	6 to 1
,, 17, 1891	Bottom	Station VII., Forth,	7	6 to 10
,, 17, 1886	,,	Mouth of Eden,	Large number	12 to 15
Sept. 8, 1886	Midwater	Off Pier Rocks, St Andrews,	1	9
,, 18, 1888	,,	St Andrews Bay,	1	9·5
,, 24, 1893	Bottom	Station I., Forth,	2	10, 11·5
Oct. 7, 1884	,,	Eden,	6	28 to 38
Nov. 1, 1888	Midwater	St Andrews Bay,	1	11

Masterman,* in his review of the work of the *Garland*, 1890-96, gives the spawning period of the plaice as extending from the beginning of February to almost the end of May. Fulton (*loc. cit.*, p. 370) gives from the middle of January to middle of May, with the maximum in early March. Allowing a little over twenty days for the period of incubation, the first appearance of the larval and early post-larval forms should be in the end of February and beginning of March. Their absence during this period can only be accounted for by the lack of data, for, at their first occurrence, April 3rd, 1893, to the east of May Island, they reach the length of 12mm., which shows that the eggs from which these earliest specimens were hatched must have been spawned some 50 days† before—that is, in the earlier part of February. The maximum spawning period is in March, and this accounts for the profusion of young post-larval forms in May, two months afterwards. The great majority of the specimens come from St. Andrews Bay and the Firth of Forth—the eggs from which these were hatched coming from off the coast of Kincardineshire (Fulton, *l.c.*, p. 374). So far as the few specimens from the north coasts, Aberdeenshire and Moray Firth, indicate anything, one may judge that the spawning season is the same for the whole East Coast.

As to the later limit of the spawning period, the examples obtained point to the conclusion that, for some years, the spawning period is continued into June, and perhaps later. Thus, the record for the year 1888 is remarkable, examples being obtained in August, September, and November. Holt (*l.c.*) mentions that some plaice spawn during August.

The majority of the specimens come from midwater and bottom, yet a great number are present near the surface, and these, the larger specimens, up to 14mm. The smaller specimens, from 6 to 8mm., are not present anywhere on the surface, but are numerous in the midwater and bottom nets. Little reliance can be placed on the lack of specimens, but it seems as if the eggs, on floating shoreward, gradually sink, the specific gravity of the water becoming less, until the larvæ are in midwater. This is more clearly seen in the region of the Moray Firth. The young post-larval forms migrate of their own accord in search of food, or are drifted by the midwater currents in which they find themselves, either to the surface or bottom. This is the stage in which the mode of life of these young flat-fish is least known. It is reasonable, however, to conclude that when in a large moving body of water they swim equally in all directions, darting about after the organisms they feed upon, and thus, in the main, are subject to the influence of the current.

Whatever be the mode of operations, the next stage finds the larger post-larval specimens close inshore, and shortly afterwards in the rock-pools. Although a large number of the small plaice are found inshore, it is possible that they are only a portion of the total. There is only negative evidence to show that these young forms must come into shallow water. Mr. Holt obtained his specimens from moderate depths, from 1 to 32 fathoms; the majority at less than nine fathoms. Plaice of 1 inch in length were obtained between 5 and 9 fathoms.

As to the specimens which come into inshore waters, one simple reason for their appearance there is that they seek the food which is necessary for them at this stage. This does not seem a sufficient reason, because the plaice, as shown above, may undergo metamorphosis, and sink to the bottom in deep water. It is doubtful, also, whether these young animals exercise discrimination in the choice of food, to such an extent, at anyrate, that food is the determining factor for the inshore migration. The currents in the North Sea are not sufficient either, though they form the most potent influence perhaps.

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* 15th S.F.B. Report, p. 219.

† Dannevig, *loc. cit.*

In St. Andrews Bay, the Firth of Forth, and the Moray Firth there are conflicting elements, which tend to nullify the offshore currents. The shallower water is more easily disturbed by any strong wind, and the influence of the rivers has to be considered. Some consideration also must be given to the configuration of the land. Thus, St. Andrews Bay seems peculiarly adapted for the shoreward migration of the plaice. The North Sea current, deflected slightly by the current from the Tay, carries its burden of eggs and larvæ along the southern shore. The east winds are blowing, as a rule, during the months of April and May, bringing the forms near the surface close into the land; but it has been noticed that the young plaice do not appear on the shore when the east winds are prevalent. This year (1897), for example, they were late in their appearance—about the middle of May. It is commonly said here that the young plaice wait for a warm day on which to approach the shore. Perhaps the concomitants of the warmth have more to do with it. On the warm days the west winds are usually blowing, thus causing a surface current seawards. There is reason to believe that these outward surface currents are compensated for by bottom currents tending inward; or, rather, that the North Sea currents, strengthened by the easterly wind, continue their course even when the wind has gone round to the west, and so bring the young plaice shoreward along the bottom, the surface forms tending outward to the sea.

The young plaice are first found on the shore in the beginning of May as a rule. During the month of May they enter the harbour of St. Andrews, and penetrate into the fresh-water burn which flows into it. They were never found beyond tidal influence. Until the middle of June, varying however, they are by themselves except for the larger flounders of the former years. As already mentioned, they are all of the same species; the dab is not amongst them. For a little over a month they monopolise the shallow water along the beach and the harbour, until the young flounders appear, and then, within the space of a fortnight, all the young plaice leave the harbour. The period when the young plaice and flounder meet was for this year (1897) the last fortnight in June. In 1887, however, it seems to have been the first fortnight, for the data show that the plaice and flounder were got together on the 8th June in the Kinness Burn, where it flows into the harbour. Dr. Petersen remarks that he never met with quite young dabs in shallow water or together with the fry of plaice and flounder; also, that the young plaice appear on the shore a little earlier in the year than the young flounder.

About a hundred of these young plaice, from 8mm. to 16mm., were examined to ascertain their food, but lack of time has prevented me from going very far into this portion of the research. The early post-larval pelagic forms contained young Annelid larvæ, the ova of some crustacean (Calanus probably), Evadne nordmanni, and in larger specimens, 13mm., larval mollusks. The Annelids were mostly larval nereids. A portion of a specimen resembling Autolytus was present in one at 14mm. Amphipods (Gammarus) were present in several. When the young plaice come into the pools and brackish water they seem to live mostly on one single form, a copepod (*Tachidius brevicornis* or *crassicornis**). Twenty of this species were found in the stomach of a plaice of 15mm.

Several parasites that infest the young flat-fish have been mentioned by Professor M'Intosh.† Several specimens of a species different from those mentioned by him were found adhering to the pectoral region, ventral and dorsal, of the young plaice and flounder, probably brought in from the sea.‡

The largest of the plaice taken from the harbour and burn was 22mm.; they migrate about that size back into the salt water. Specimens from three to four inches were obtained close to the rocks by the pier. It is possible, however, that even at this early stage they begin their northward migration.§ At the mouth of the Eden they are obtained of a size from 12mm. to nearly 4 inches during May to September. The rate of growth of the plaice has been sketched by Masterman. [Footnote Thirteenth Annual Report Fishery Board for Scotland, Part III., p. 289.]

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* T. Scott, 10th S.F.B. Report, p. 250.

† "Researches," p. 843. 9th S.F.B. Report, p. 330.

‡ On these Mr. Calman, B.Sc., to whose kindness I am much indebted, has made the following note :—

The three specimens sent are the *Praniza* or larval form of a species of *Gnathia* which I have not been able to identify. It differs from the common *Gnathia maxillaris Mont.*, and, indeed, from all the forms described in Spence, Bate, and Westwood's British Sessile-eyed Crustacea, and in Sar's Crustacea of Norway, vol. ii., in the short and rounded telson, which is much shorter than the inner plates of the mopods. I have compared the specimens with a series in the Museum of University College, comprising many stages of both sexes from different parts of the British coasts, and have found none to agree with them in this respect. It is almost impossible, however, to determine the species with certainty until the adult forms have been found. The occurrence of a species of this genus in fresh (or brackish) water is a very interesting, and, so far as I know, a new observation.

W. T. C.

University College,
Dundee, 28th October 1897.

§ Migrations of the Food-Fishes. Dr. Fulton, 11th S.F.B. Report, p. 176.

[Table

DAB.

Date.	Net.	Place.	Number of Specimens.	Size in mm.
Apr. 8, 1895	Surface	St Andrews, ...	1	14
,, 15, 1889	,,	,, ...	6	9 to 13
,, 22, 1895	,,	Station VIII., Forth, ...	1	9
,, 26, 1888	Midwater	St Andrews, ...	1	27
,, 15, 1889	Bottom	,, ...	9	9 to 12·5
,, 17, 1895	,,	Station III., Forth,... ...	1	13·5
,, 19, 1895	,,	St Andrews, ...	1	8·5
,, 21, 1892	,,	Station II., Forth, ...	...	Larval
,, 26, 1890	,,	Station VIII., ...	1	13·5
May 14, 1889	Surface	St Andrews, ...	20	5 to 12·5
,, 16, 1894 ,, 19, 1894	,,	15 miles off coast, Montrose to Aberdeen, ...	Over 3000	10 to 16
,, 20, 1890	,,	Station I., Aberdeen, ...	1	15
,, 5, 1887	Midwater	St Andrews, 4 fathoms, ...	2	14, 16·5
,, 10, 1888	,,	,, ...	1	15
,, 12, 1891	,,	S.E. of May Island, 10 fathoms,	16	6 to 12
,, 26, 1892	,,	Liston Bank,...	3	5 to 12
,, 31, 1892	,,	Cross-section III., Forth, ...	6	8 to 14·5
,, 2, 1890	Bottom	St Andrews, ...	2	9, 14
,, 4, 1888	,,	... ...	2	Larval
,, 13, 1892	,,	... ...	2	11, 13
,, 19, 1890	,,	Stations I. and II., Montrose,	20	5 to 11
,, 20, 1891	,,	St Andrews, ...	2	13, 15
,, 20, 1890	,,	Stations I. & III., Aberdeen,	25	5 to 12
,, 22, 1890	,,	Station V., ...	9	5 to 15
,, 27, 1890	,,	Station IV., Moray Firth,...	3	13 to 15
June 13, 1893	Surface	Station V., Forth, ...	2	11, 11·5
,, 4, 1895	Bottom	Station V., St Andrews, ...	1	8
,, 5, 1889	,,	St Andrews, ...	3	6 to 7
,, 5, 1892	,,	,, ...	3	6
,, 5, 1868	,,	West Sands, ...	3	18, 21, 26
,, 7, 1888	,,	St Andrews, ...	4	36, 37·5, 40, 42
July 2, 1891	Midwater	Off Elie, ...	1	14·5
,, 3, 1891	,,	Station I., St Andrews, ...	2	11, 12·5
,, 10, 1892	Bottom	St Andrews, ...	2	15·5, 17·5
,, 21, 1891	,,	Station IX., Forth,... ...	5	4 to 6
,, 31, 1891	,,	West of May Island, mid-channel,	6	7 to 9
,, 5, 1888	,,	St Andrews, ...	2	48·5, 59
Aug. 18, 1886	Midwater	Between Boarhills and Eden, 3 fathoms,	5	5 to 8
,, 21, 1891	,,	Off Elie, near mid-channel, 12 fathoms,	10	5 to 8
,, 26, 1888	,,	St Andrews Bay, ...	7	11·5 to 15
,, 28, 1891	Bottom	Station II., Montrose, ...	1	9
Sept. 29, 1893	,,	Station IX., Forth,... ...	4	5 to 7
,, 11, 1889	,,	Eden, ...	3	46, 49·5, 53·5
...	...	... ...	5	70 to 106
Oct. 2, 1887	,,	St Andrews Bay, ...	6	49, 70
Jan. 19, 1892	,,	Station II., Forth, ...	2	17·5
Feb. 9, 1884	,,	St Andrews, ...	1	38
Mar. 4, 1892	,,	,, ...	21	20, 52

The dab spawns both in inshore and offshore waters. Its spawning period lasts (Fulton, *l.c.*) from the end of February to middle of July, with the mean in April, May, and June. It may extend later, however, for (Masterman, *l.c.*) its eggs have been obtained throughout July to the end of August.

The data correspond, for the earliest, obtained in April, must have been spawned in February, six weeks before; the latest, at the end of September, must have been spawned in the beginning of the month. This is of importance in connection with its rate of growth. Mr. Williamson,* taking the spawning period as from March to mid-June, calculates that a dab grows to 60 or 70mm. in one year. Even on the extended period this represents the *average* growth. A series of larger forms have been given for each month in the year, except May, and it is not difficult to trace approximately the rate of growth, but, as this has been done by Williamson, and the conclusions are much the same, there is no need to go into details.

Turning to the pelagic forms, it has to be noted again that the larval and early post-larval specimens are obtained from the midwater and bottom nets; only once was a specimen 5mm. long taken on the surface in company with others 12·5mm. in length. The later post-larval stages are found on the surface, midwater, and bottom. The offshore distribution is noticeable in contrast with that of the plaice. Professor M'Intosh,† in 1884, made a reference to the large number of immature examples of the dab, from 2¾ to 6 ins., which were obtained from the deep water 15 miles from St. Abb's Head, more especially during July and August. No young plaice were found in their company, and he concludes that the occurrence of such small specimens so far from land would raise a doubt as to whether all the young forms have been reared inshore. A large number of the young dabs of the same size were also obtained in St. Andrews Bay, a mile or two from land, in about 4 to 6 fathoms of water. Close inshore the young dabs are not taken except off the rocks; some few are taken at the mouth of the Eden. The distribution of the young dabs from 1 inch onward is thus extensive, and there does not seem any need of supposing that any great migration of the adults takes place. From the early post-larval stages the dab is near the haunts of the adult.

On the 16th to 19th May 1894, over 3000 young dabs, from 10 to 16mm., were obtained, 15 miles from land, in the surface net. It is possible, considering the short period of incubation, that these specimens were not far from where the eggs were spawned, and it is possible, also, that they never migrate far from the spot where they were found. Some of the specimens (30) were examined as to their food contents. Only diatoms were found in their stomachs, and one or two were crammed full with them. The diatoms were of three distinct species at least (Coscinodiscus and others), but I have not been able to connect them with the scheme of Professor Cleve. Crustacea were present in the water, though none were found in the stomachs of the specimens examined. A difference was noted between the deep-sea and the inshore specimens (figs. 8, 9, 10). The deep-sea specimens were longer at each stage during metamorphosis—thus, the eye was halfway at 15 to 16mm., whereas, in the inshore forms, 14 to 15mm. was the rule. Black pigment was very well marked along the base of the fins, etc., in deep-sea specimens, and the lines along the myomeres were present. Though present it is not so prominent in the inshore forms.

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* Rate of Growth of Certain Marine Fishes, 11th S.F.B. Report, p. 265.

† Commission on Trawling, 1884, p. 361.

LONG ROUGH DAB.

Date.	Net.	Place.	Number of Specimens.	Size in mm.
April 18, 1895	Surface	Station II., Forth, ...	1	9·5
May 7, 1892	Midwater	7 miles S.S.E. of Bell Rock,	9	7 to 13
,, 11, 1891	,,	4 miles E. of May Island, 10 fathoms,	3	4 to 10
,, 15, 1890	,,	Station VIII., Forth, ...	11	10 to 21
,, 31, 1892	,,	Cross-section III., Forth, ...	5	11 to 14
,, 2, 1893	Bottom	Station IV., Moray Firth, ...	1	9
,, 11, 1893	,,	Station VI., Smith Bank, ...	3	8 to 11
,, 11, 1896	,,	St. Andrews,...	5	4 to 11
,, 20, 1890	,,	Station III., Aberdeen, ...	4	10 to 12
,, 22, 1892	,,	N.W. of Aberdeen, ...	5	10 to 14
,, 25, 1895	,,	Station VII., Forth, ...	2	5, 9
,, 26, 1892	,,	Between Liston Bank and May Island,	13	8 to 11
,, 27, 1892	,,	Cross-section II., North half, Forth,	4	5 to 14
,, 28, 1895	,,	Station VIII., Forth, ...	2	7, 8
June 1, 1888	Midwater	St. Andrews, ...	6	11 to 12
,, 9, 1892	,,	Stations VIII. and IX., Forth,	8	9 to 21
,, 10, 1892	,,	Stations I. and II., Forth,...	6	12 to 17
,, 13, 1892	,,	Station V., Forth, ...	3	6 to 13
,, 13, 1888	,,	St. Andrews, ...	3	8 to 9
,, 15, 1892	,,	Station II., Forth, ...	0	9 to 20
,, 22, 1893	Bottom	Cross-section II., South half, Forth,	1	14
,, 23, 1893	,,	12-14 miles off Aberdeen, ...	1	18
,, 24, 1895	,,	St. Andrews, ...	2	8, 12

Dr. Fulton gives the spawning period of the long rough dab as from the end of January to middle of May. The collections fairly well correspond with this. There are no specimens during March and the first part of April, and no specimens after the 24th of June. The latter fact is remarkable. The largest specimens, with metamorphosis barely half complete, were 21mm. long. Specimens from that size onwards are absent. The conclusion seems to be that they disappear from the inshore water, migrating seawards.

Whether they migrate by instinct or are drifted by currents may be disputed. If drifted by currents, then there must be undercurrents tending from the shore out to the sea. Only one specimen was obtained on the surface far up the Forth; all the others were from midwater and bottom. Professor M'Intosh, on the Trawling Commission, found the young long rough dabs, from $1\frac{1}{8}$ to $3\frac{1}{4}$ inches, in company with the dab on the ground 15 miles off St. Abb's Head; also off St. Andrews Bay and Aberdeen Bay. The long rough dab, therefore, corresponds closely to the off-shore specimens of the dab. It does not appear to frequent the inshore waters.

The data are too few to give any accurate notion of the rate of growth; but, if the specimens from Station VIII., Forth, on 15th May, be considered, the largest, 21mm., can be chosen to representthe earliest hatched. Taking 18 days as the period of incubation during February—it is 16 days during March (Fulton) and a similar period for the larval stage (M'Intosh)—and calculating from the 1st of February, this specimen has taken a little over two months during the early post-larval stages alone. Possibly another four weeks might be required to complete metamorphosis, though it may be very rapid during its later stages.

FLOUNDER.

Date.	Net.	Place.	Number of Specimens.	Size in mm.
April 13, 1889	Bottom	St. Andrews Bay, ...	3	7·5 to 8·5
,, 27, 1889	,,	,, ...	1	8·5
May 31, 1892	Surface	Station II., Forth, ...	2	5, 7
,, 31, 1892	Midwater	Cross-section III., Forth, North half,	7	3 to 7
,, 6, 1891	Bottom	Station IV., Forth, ...	1	4
,, 20, 1890	,,	Station I., Aberdeen, ...	4	5
,, 28, 1890	,,	St. Andrews,...	1	8
,, 29, 1890	,,	Moray Firth, ...	4	4 to 7
June 9, 1892	Midwater	Station VIII., Forth, ...	7	5 to 8
,, 28, 1887	,,	In Harbour, ...	1	8
,, 5, 1889	Bottom	St. Andrews,...	1	8·5
,, 6, 1895	,,	Station IV., St. Andrews,...	4	7
,, 8, 1887	,,	Kinness Burn, ...	8	10 to 12
,, 8, 1887	,,	,, ...	1	21
July 5, 1888	,,	St. Andrews Bay, ...	2	8
,, 8, 1891	,,	Kirkcaldy Bay, ...	2	8, 9·5
,, 16, 1895	,,	St. Andrews, ...	1	8
,, 22, 1891	,,	Station IV., St. Andrews, ...	1	6
		Forth and St. Andrews Bay.*		
,, 16, 1897	,,	Kinness Burn, ...	Large no.	12 to 21
Aug. 18, 1891	,,	Station V., Forth, ...	1	8
Sept. 10, 1888	Midwater	St. Andrews Bay, ...	1	6·5

* Number of larval and early post-larval forms.

Fulton gives the spawning period of the flounder as from the beginning of February to the end of June, Masterman from the beginning of March to the end of June. The number of specimens partly fits in with the latter period. It is strange, however, that no more specimens were obtained during April. The month of March does not seem to have been closely investigated for the young post-larval forms, none of the species being represented. The small number of specimens is striking, especially as the flounder produces more than four times the number of eggs that the plaice does, and fourteen times as many as the dab. The reason for this is that the flounder spawns in the inshore waters for the most part, and, therefore, that the young post-larval forms are never far away from land. The collections, which are taken from 7 to 10 miles to sea, contain the eggs but not post-larval specimens. Another reason for the small numbers is the early metamorphosis of the flounder. The pelagic free-swimming stages are from 4 to 9mm. only. A number of the early post-larval specimens from 4 to 6mm., which have been omitted from the list, may be flounders.

As already mentioned, the young flounders enter the harbour here somewhat later than the plaice. This is remarkable, since, though spawned later than those of the plaice, its eggs hatch much quicker.

Whatever be the reason, the young flounders appear in June while the plaice appear in May, and, instead of returning to the sea within a short period as the plaice do, they proceed far up the streams.

The distribution of the lemon dab is held over for the present.

In conclusion, I desire to express my obligation to Professor M'Intosh for his kindly criticism.

PLATE X.

1

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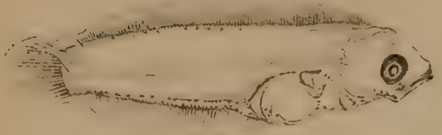

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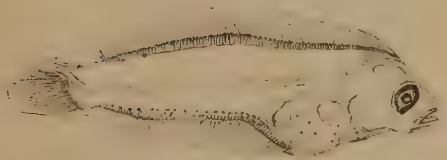

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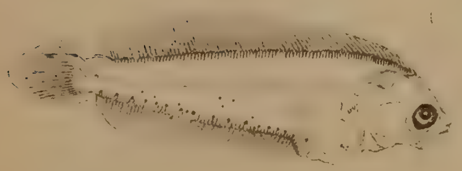

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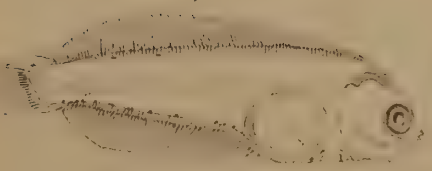

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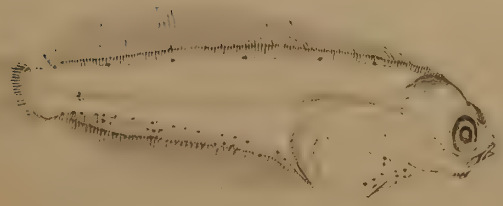

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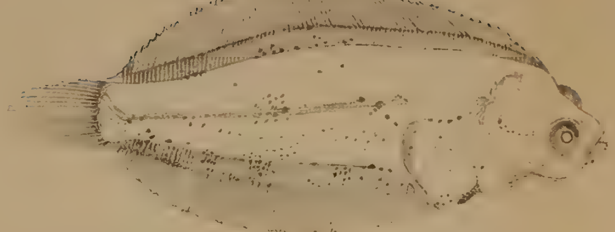

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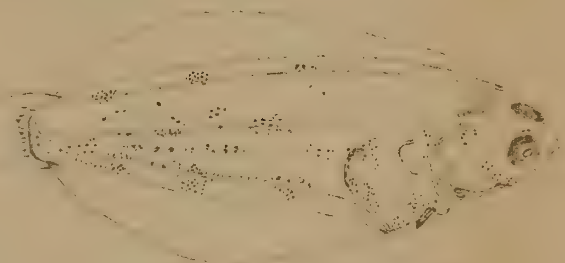

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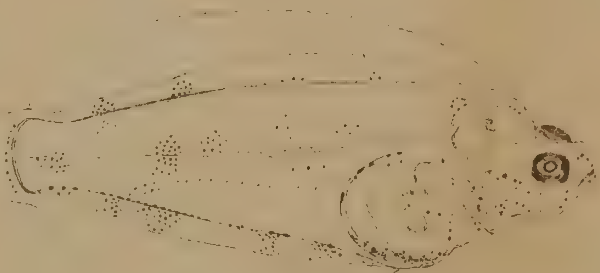

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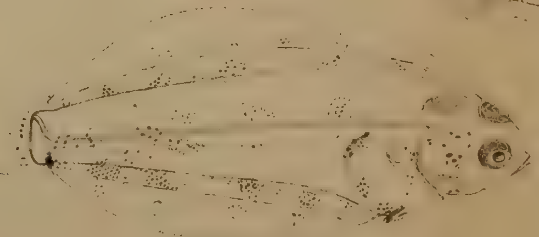

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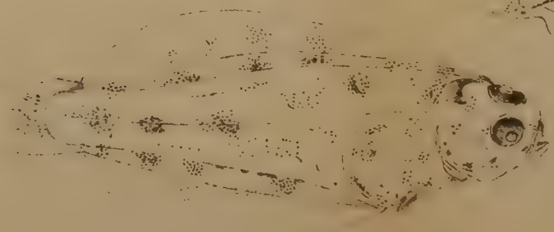

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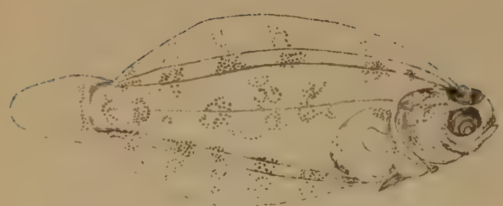

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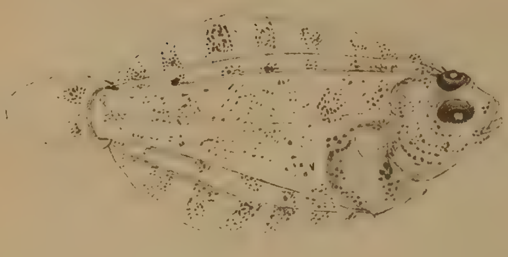

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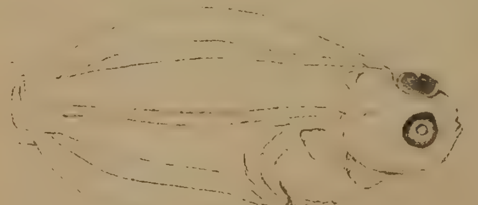

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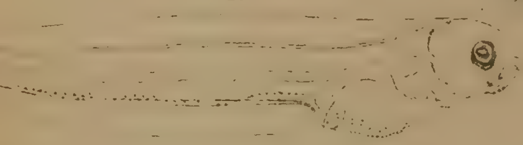

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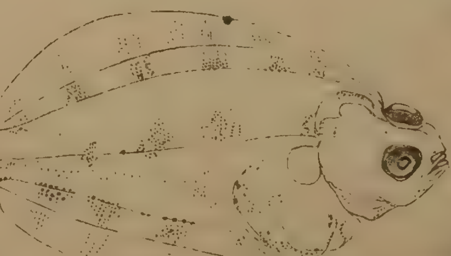

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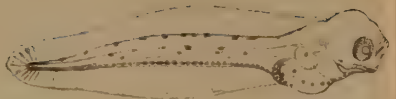

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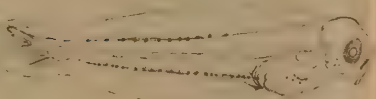

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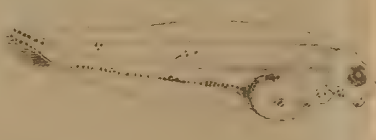

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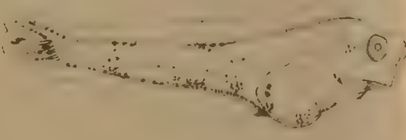

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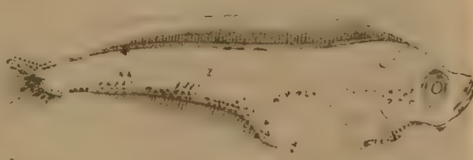

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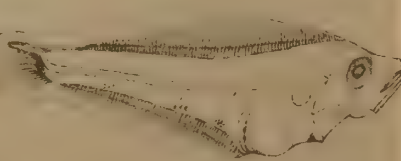

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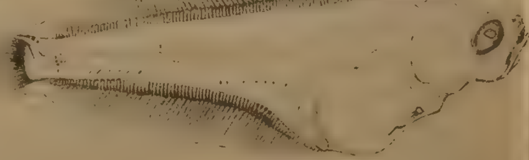

PLATE XI

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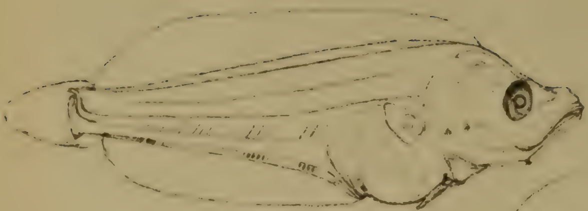

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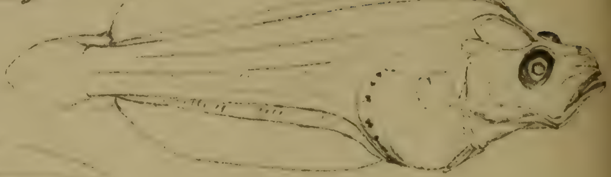

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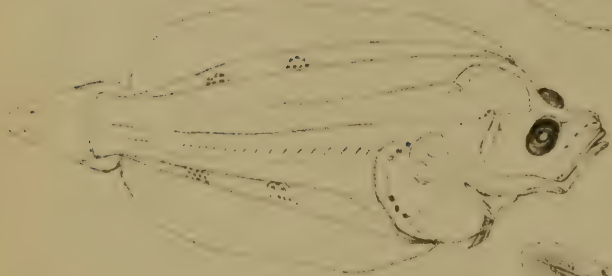

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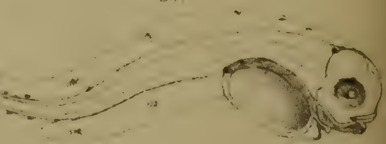

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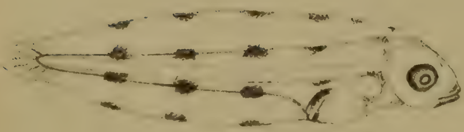

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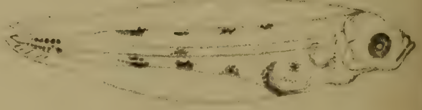

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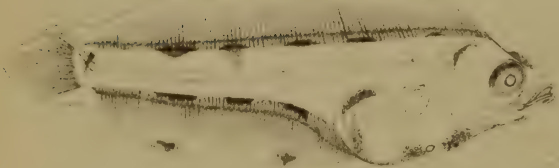

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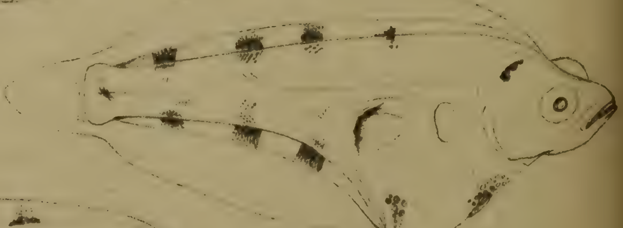

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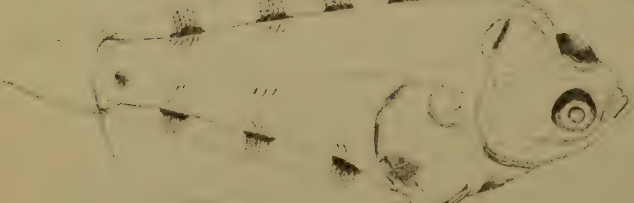

EXPLANATION OF PLATES X. AND XI.

The majority of the figures were outlined by *camera lucida;* those not so outlined were Figs. 9, 16, 25, 26, 31, 32.

The pigment of Figs. 27 and 28 was not present in the spirit specimens, and was drawn in from the figures in "British Marine Food-Fishes."

Fig. 1.	Dab,	5mm.,	× 10 nearly.
,, 2.	,,	6mm.,	× 9.
,, 3.	,,	8mm.,	× 7.
,, 4.	,,	9·5mm.,	× 6.
,, 5.	,,	10·5mm.,	× 6.
,, 6.	,,	12mm.,	× 6.
,, 7.	,,	13mm.,	× 6.
,, 8.	,,	13·5mm.,	× 6.
,, 9.	,,	14mm. (deep-sea specimen),	× 6.
,, 10.	,,	14·5mm.,	× 5½.
,, 11.	,,	15mm.,	× 5.
,, 12.	,,	16mm.,	× 4 nearly.
,, 13.	,,	16·5mm.,	× 4.
,, 14.	Flounder,	8mm.,	× 8½.
,, 15.	Plaice,	8mm.,	× 10.
,, 16.	,,	12mm.,	× 6.
,, 17.	Long Rough Dab,	4·5mm.,	× 12 nearly.
,, 18.	,,	6mm.,	× 9 ,,
,, 19.	,,	7mm.,	× 7.
,, 20.	,,	9mm.,	× 6.
,, 21.	,,	10mm.,	× 6.
,, 22.	,,	11·5mm.,	× 5.
,, 23.	,,	14mm.,	× 5½.
,, 24.	,,	16mm.,	× 4½.
,, 25.	,,	18mm.,	× 4½ nearly.
,, 26.	,,	20mm.,	× 4 ,,
,, 27.	Lemon Dab,	4mm.,	× 14.
,, 28.	,,	5·5mm.,	× 10.
,, 29.	,,	7mm.,	× 7.
,, 30.	,,	12mm.,	× 5½.
,, 31.	,,	14mm.,	× 5½.
,, 32.	,,	19mm.,	× 4.

As these Drawings were intended as aids to the separation of the different species, only the necessary details were drawn. Numerous other drawings, especially of the plaice, lemon dab, and flounder, will be found in the works of the authors quoted.

XI.—THE INVERTEBRATE FAUNA OF THE INLAND WATERS OF SCOTLAND.—Part VIII. By Thomas Scott, F.L.S., Mem. Soc. Zool. de France. Including an ACCOUNT OF THE EXAMINATION OF SOME OF THE LOCHS OF SHETLAND. By Thomas Scott, and Robert Duthie, Fishery Officer.

PRELIMINARY.

In submitting the results of some further researches into the distribution of the fresh-water invertebrata, I desire first of all to state that, at the request of the Fishery Board, a certain number of the fresh-water lochs of Scotland are at present being examined at stated intervals and apart from the researches hitherto carried on. The purpose of this special work is to ascertain what effect—if any—seasonal variation has on the micro-fauna and micro-flora of the lochs; whether there is a tendency on the part of these organisms to increase or decrease in number as the seasons vary, and to obtain a more exact knowledge of the effect this seasonal variation has on the development of fresh-water invertebrates and plants. Any other point of interest in connection with this inquiry that may be observed is also being noted.

The following are the lochs that have been selected for special investigation:—Forfar Loch, near the town of Forfar; Loch Leven, Kinross; Loch Lomond; Loch Katrine; Loch Arklet (situated between Loch Lomond and Loch Katrine); Loch Achray, Trossachs; Loch Doon, Ayrshire; and Duddingston, near Edinburgh. Loch Lomond and Loch Katrine are typical deep-water lochs; Loch Arklet and Loch Doon are upland lochs, and are situated at a considerable elevation above sea level, Loch Doon being about 660 feet above the sea. Forfar Loch, Loch Leven, and Duddingston, on the other hand, are all more or less typical low-lying shallow lochs.

These lochs are being examined at intervals of about three months, and the examination is made by tow-netting in the open water from a rowing boat. Two tow-nets of different degrees of fineness are used in this work —one of ordinary fineness for the capture of Entomostraca and similar organisms, and one of silk cloth, very small in the mesh, and made specially for collecting Infusoria, Diatomacea, etc. Suitable portions of the shore are also carefully examined by hand-net, as numbers of invertebrates, instead of voluntarily resorting to the open water, seek the shelter of the vegetation growing along the shore or in the shallows, and are usually only to be obtained there.

But in addition to the examination of the lochs referred to, a similar series of observations are being made from time to time on board the *Garland* into the distribution of the invertebrates and algæ of Loch Ness, Loch Oich, and Loch Lochy. The results of this additional work will be incorporated with those of the other lochs, and will no doubt help to throw additional light on the conditions affecting the distribution and development of fresh-water organisms—organisms that directly and indirectly are the chief source of food of the fresh-water fishes.

This inquiry into the seasonal variation of fresh-water organisms is not yet completed, and it may therefore be better to defer giving a detailed report on the results obtained so far until the experiments are finished, when a full report on all the lochs under special examination will be prepared and submitted to the Board.

But though it may be desirable at this stage of the special inquiry to defer the preparation of a report on any results obtained, it may not be out of place to state that a few interesting facts bearing on the distribution of fresh-water Entomostraca have already been secured. In Loch Doon, for example, a Copepod (*Diaptomus laciniatus*) was discovered which has not previously been known to occur in Britain, and which has been found in only a few places on the continent of Europe, as at Kola (within the Arctic circle) in Lapland; near Bergen in Norway; in the district of Schwarzwald, Germany; and in the Lake of Geneva—a distribution which tends to show that probably the normal habitat of this species is in the lakes of alpine or sub-alpine regions. The occurrence of this species may also have some bearing on distribution in reference to surface changes, with which only the geologist can deal. Another Copepod (*Diaptomus wierzejskii*), hitherto comparatively rare in lakes on the mainland of Scotland, was found in Loch Achray; and a third member of the same genus (*Diaptomus hircus*) was moderately frequent in some tow-net gatherings from Loch Lochy and Loch Ness, which extends the distribution of these species considerably. Moreover, a member of the Harpacticidæ (*Marœnobiotus vejdovskei*) that has once before been recorded for Britain was found moderately frequent in Loch Doon in December.

Besides the discovery of rare forms, certain points of interest bearing on seasonal variation in the number of male *Daphnia*, and on some aspects of the question of the reproduction of the Entomostraca in relation to the different seasons of the year, are also being noted, and will be discussed in the report that deals with the results of this series of special observations.

I pass on now to give an account of the examination of several fresh-water lochs of Scotland, apart from those referred to above, that have been investigated during the past year. They are described in the same order that was observed in a somewhat similar paper on inland waters prepared for last Annual Report. The description of the lochs is arranged under two divisions. The first division includes descriptions of a few lochs (other than those of Shetland), whilst descriptions of a number of the Shetland lochs are contained in the second division.

DIVISION I.

Description of some Lochs (other than those of Shetland) examined during the past year.

(1) Small Loch near the Village of Lochranza, Arran.

This small loch, or tarn, which appears to have been at one time considerably larger than it is now, was examined last year on the 19th of May, and at that time tadpoles were exceedingly numerous in the water, consequently Entomostraca, as might have been expected, were scarce—indeed there was little else besides tadpoles to be seen. It is probable that but for the presence of these hungry, ravenous creatures, the number and variety of smaller organisms would have been considerable, for, notwithstanding the conditions referred to, sixteen species of Crustacea were observed: they include four species of Copepoda, nine of Cladocera, and three of Ostracoda. The names of all the species are given in the Table at the end of the paper, but the following may be specially mentioned here: *Acantholeberis curvirostris*, *Drepanothrix dentata*, *Alona rustica*, and *Ilyocryptus sordidus*.

(2) GARRY LOCH ON AILSA CRAIG, FIRTH OF CLYDE.

This little tarn—all that now remains of a "lochan" that was once apparently of considerable depth—was visited during the month of May last year while the s.s. *Garland* happened to be at anchor for a short time under the shelter of the rock. Two species of Copepods and two of Cladocera sum up the list of Crustacea obtained, yet three out of the four are comparatively rare. One of the Copepods was *Moraria anderson-smithi*, T. and A. Scott, and the other *Cyclops bisetosus*, Rehberg; while one of the two Cladocera was *Alona rustica*, T. Scott, the other being the almost universally diffused *Chydorus sphæricus.*

(3) PARK LOCH, NEAR CAMPBELTOWN (CANTYRE).

This loch is situated on the uplands to the north of Campbeltown (Cantyre). It appears to have been at one time much larger than at present, but portions at either end seem to have become gradually filled up, and thus reduced to a considerable extent the limits of the loch. In summer a fringe of luxuriant vegetation—extensive in some parts—stretches nearly all round the loch, and affords shelter and food to a rich Entomostracan fauna. Forty-seven species of Crustacea were obtained in some gatherings collected in August. A tow-net gathering collected in the open water by means of a rowing-boat yielded a large quantity of Entomostraca, but there was very little variety in respect of the number of species. Most of the species mentioned in the Table under Park Loch were obtained in shore gatherings collected with a hand-net. The Crustacea obtained in this loch comprised 14 species of Copepoda, 17 species of Cladocera, and 15 species of Ostracoda, and the Amphipod *Gammarus duebeni* was also observed. The Copepods include such forms as *Cyclops bicolor*, *Canthocamptus inornatus*, and *Canthocamptus schmeilii;* while among the Ostracoda were *Candona hyalina* and *Darwinula stevensoni;* and *Alona rustica* among the Cladocera—all of which are comparatively rare.

(4) TANGY LOCH, NEAR CAMPBELTOWN (CANTYRE).

This loch, situated at the head of Tangy Glen, is a short distance northwestward from Park Loch, and occupies a somewhat higher elevation. The physical conditions are also somewhat different: the shore nearly all round is shingly or rocky, and consequently there is not such an amount of aquatic vegetation. Spongilla appears to be common in the loch: large pieces of it, partially decayed, were observed at various places along the shore at the time of our visit. Pelagic Entomostraca were common, but embraced few species, and it was found here, as elsewhere, that shore gatherings yielded by far the largest variety of forms; but both modes of collecting are necessary, as some species are only to be obtained in the open water. Owing to the absence of vegetation the variety of the Crustacean fauna was less than in Park Loch: 27 species in all were observed, comprising 10 species of Copepoda, 8 species of Cladocera, and 8 species of Ostracoda, while a *Gammarus* (*G. duebeni*) was also obtained here. One of the Copepods from Tangy Loch is *Canthocamptus hirticornis*, T. Scott, a species not hitherto observed in the Campbeltown district. A few molluscs, insects, and statoblasts of *Cristatella*, as well as some other forms, were also observed in the gatherings.

In referring to the statoblasts of *Cristatella*, it seems necessary to draw attention to the fact that the number of marginal spines varies considerably in different specimens. Exception has been taken to my figure in Part III. of the Fourteenth Annual Report because the number of spines shown there is considerably greater than is represented in Professor Allman's figures of the same objects in his valuable 'Monograph of the Fresh-water Polyzoa.' Whatever be the reason of the difference, the number of spines shown in my figure is the number on the specimen I have given a representation of.

This completes the description of the lochs coming under the first division of this paper, and I now append a Table showing the number and distribution of Crustacea from the lochs referred to, as it is desirable, for the sake of continuity, to reserve the second division for the description only of the lochs of Shetland.

In concluding this part of my paper on the fauna of inland waters, I desire to state that my successful examination of the lochs about Campbeltown is due in great measure to the kind assistance afforded me by Mr. Alexander Gray and other friends residing there.

TABLE containing the Names and showing the Distribution of all the Species from the Lochs referred to in the preceding Notes.

Names of the Species.	Lochs in the vicinity of Campbeltown, Cantyre.		Loch on Ailsa Craig.	Loch in Island of Arran.
	Park Loch.	Tangy Loch.	Garry Loch.	Loch n'r Lochranza.
MOLLUSCA.				
Pisidium sp.,		×		
Planorbis nautileus (Linné),		×		
,, *albus*, Müller,		×		
Limnæa peregra (Müller),		×		
Ancylus fluviatilis, Müller,		×		
CRUSTACEA.				
AMPHIPODA.				
Gammarus duebeni, Lilljeborg,	×	×		
COPEPODA.				
Diaptomus hircus, Brady,		×		
Cyclops strenuus, Fischer,	×	×		
,, *vernalis*, Fischer,		×		
,, *bisetosus*, Rehberg,			×	
,, *viridis* (Juriné),	×	×		
,, *(?) bicolor*, G. O. Sars,	×			
,, *fuscus* (Juriné),	×			
,, *albidus* (Juriné),	×	×		
,, *serrulatus*, Fischer,	×	×		
,, *fimbriatus*, Fischer,	×	×		×

TABLE containing the Names and showing the Distribution of all the Species from the Lochs referred to in the preceding Notes—*continued.*

Name of the Species.	Lochs in the vicinity of Campbeltown, Cantyre.		Loch on Ailsa Craig.	Loch in Island of Arran.
	Park Loch.	Tangy Loch.	Garry Loch.	Loch n'r Lochranza.
Canthocamptus staphylinus (Juriné),	×			
,, *schmeilii*, Mrazek,	×			
,, *inornatus*, T. Scott,	×			
,, *minutus*, Claus,	×			
,, *hirticornis*, T. Scott,		×		
Attheyella crassa (G. O. Sars),	×	×		×
,, *pygmæa* (G. O. Sars),	×	×		×
,, *zchokkei*, Schmeil,	×			
Moraria anderson-smithi, T. & A. Scott,	×		×	
OSTRACODA.				
Cypria ophthalmica (Juriné),	×	×		×
Cyclocypris lævis (Müller),	×	×		
,, *serena* (Koch),	×	×		×
,, *globosa* (G. O. Sars),	×			
Cypris obliqua, Brady,		×		
Herpetocypris reptans (Baird),	×			
,, *strigata* (Müller),		×		
Cypridopsis villosa (Juriné),	×			×
Pionocypris vidua (Müller),	×			
Ilyocypris biplicata (Koch),	×			
Potamocypris fulva, Brady,		×		
Candona candida (Müller),	×	×		
,, *lactea*, Baird,	×			
,, *Kingsleii*, Brady and Robertson,	×	×		
,, *(?) compressa* (Koch),	×			
,, *hyalina*, Brady and Robertson,	×			
Darwinula stevensoni, Brady & Robertson,	×			
Limnicythere inopinata (Baird),	×			
CLADOCERA.				
Sida crystallina (Müller),	×	×		
Bosmina longirostris (Müller),		×		
Daphnella brachyura (Lievin),	×	×		
Acantholeberis curvirostris (Müller),				×
Drepanothrix dentata (Euren),				×
Ilyocryptus sordidus (Lievin),	×			×
Ceriodaphnia quadrangula (Müller),	×			
,, sp.,		×		
Simocephalus vetulus (Müller),	×			
Daphnia longispina (O. F. Müller),	×			
Acroperis harpæ, Baird,	×			×
Alonopsis elongata, G. O. Sars,				×
Alona affinis, Leydig,	×	×		×
,, *(?) quadrangularis* (Müller),	×			
,, *rustica*, T. Scott,	×		×	×
,, *(?) intermedia*, G. O. Sars,	×			
Harporhynchus falcatus, G. O. Sars,		×		
Chydorus globosus, Baird,	×			
,, *sphæricus* (Müller),	×	×	×	×
,, *barbatus* (Brady),	×	×		×
,, *(?) cælatus*, Schoedler,	×			
Polyphemus pediculus (De Geer),	×			

DIVISION II.

ACCOUNT OF THE EXAMINATION OF SOME OF THE LOCHS OF SHETLAND.

By THOMAS SCOTT AND ROBERT DUTHIE.

The present is our fourth contribution towards the elucidation of the fresh-water fauna of the Shetland Islands. Twelve of the lochs of Shetland are described in the present paper, and are referred to in the following order :—(1) The district of Lerwick, one of the lochs is described ; (2) Northmavine, six of the lochs are described ; (3) the island of Bressay, one loch is described ; (4) island of Yell, two of the lochs are described ; and (5) Helliers Water, in the island of Unst, is described.

The first portion of the paper contains a series of notes on the physical aspects of each of the lochs examined, and on any other point of general interest ; the second portion comprises a series of faunistic notes, describing briefly the results of the examination of each of the gatherings collected and arranged as in the first portion. Special reference is also made to any particularly rare or interesting species.

THE FRESH-WATER LOCHS OF SHETLAND.

NOTES ON THEIR PHYSICAL ASPECTS.

(1) *Lerwick District.*

LOCH OF KEBISTER, GREMISTA, LERWICK.

(Examined April 14th 1897.)

This loch lies about a mile north from the farm-house of Gremista, near Lerwick. It was examined about 4 p.m., the day being bright, but the weather only beginning to improve after a very severe winter and spring. The loch lies some 200 feet above the level of the sea near the top of the hill of Gremista. The surrounding ground is deep moss, but the loch has a beach of fine gravel extending along the greater part of its shores, and the water is very clear and transparent. Fauna did not appear to be numerous, but were fairly well distributed round the margin. Had the loch been visited in summer, the gathering would no doubt have been larger.

(2) LOCHS IN NORTHMAVINE.

Having no opportunity of examining the lochs in this part of Shetland, as our visits were few and hurried, the work had to be done by deputy. Messrs. Burgess and Stove, two Lerwick gentlemen who were at North Roe on holiday, made the collections for us ; and to them we are also indebted for a description of the lochs and their surroundings.

Loch of Flugarth, North Roe.

(Examined April 22nd 1897.)

This loch lies low, having crofts all along the S.E. side, the watershed being the hills on the S.W. A burn from the north end of the "Buirgs" enters its S.W. side, and another burn at its north end connects it with

Sandvoe, an inlet of the sea which is about 80 yards distant. This is reported to be a fair loch for trout. The shores are stony, and the water clear; but one or two draws of the hand-net were sufficient to stir up decayed grass and mud. Life seemed very minute, and most plentiful on the N.W. side. No vegetation was visible. The loch was examined at 11 a.m., the day being dull but warm.

Loch of Houllsquey, North Roe.

(Examined April 22nd 1897.)

This loch, which is of medium size, lies on the N.E. side of the district, and practically on the edge of a precipice. There seems to be no burn falling into the loch, only a small, sluggish, stagnant ditch, thickly grown with weeds. This part of the loch appeared to be the most likely to yield a good collection, but it was unapproachable. The landward side is boggy, of uniform depth, and very muddy. The other side is extremely shallow, with clear water and shingly bottom, but no point of vantage from which to work the hand-net. The watershed is from a low, grassy hill. The outlet from the loch runs N.W., finding its destination in Sandvoe.

Loch of Benigarth, North Roe.

(Examined April 22nd 1897.)

A steep, grassy hill, thickly interspersed with stones, rises on the south side of this large loch. A grassy bank forms its edge, and the water is deep and dark. Farther along, where the township of Setter lies, the cultivated land extends almost to the loch, separated only by a strip of miry ground. Small-sized algæ grow in profusion on the bottom, and life is abundant. A smaller loch, the loch of Setter, contributes a stream which filters its way into this loch at the S.E. shore. Time did not permit of our visiting it. The loch of Benigarth, like the others visited the same day, sends a burn down to Sandvoe. The collection from it was made at 7.30 p.m.

Moosa Water, North Roe.

(Examined April 23rd 1897.)

This large loch lies in a dreary region known locally as "Da back o' da Buirgs," a range of rough granite hills that rise to upwards of 600 feet above sea level. The loch itself has an altitude of 450 feet. It was visited about noon, the day being bright and warm. The land for several hundred yards all round is level, or as level as granite boulders will permit. The shores and bottom are rocky, and the water at many points over six feet deep. There was too much mud and slime to permit of a very satisfactory search, but fauna seemed scarce, and the specimens obtained appeared to be very minute.

Mill, or Ennis Loch.

(Examined April 23rd 1897.)

This small loch was examined directly after the former, and as the gathering appeared to be very meagre, it was mixed with the collection obtained from Moosa Water. The loch is surrounded by moor, and the water is very dark and muddy. Algæ and fauna seemed alike scarce.

Pettidale Water.

(Examined April 23rd 1897.)

Examined about 2 p.m., weather fine. Granite rocks fringe the shore; the north end of the "Buirgs" forms one side, the other being broken ground, with moss and heather. Animalculæ seemed scarce and minute. The loch has an altitude of between 400 and 500 feet.

Innis Loch.

(Examined April 23rd 1897.)

This is a small, shallow-margined pool, with a good deal of mossy sediment about the sides and bottom, and with a number of watercourses draining into it from the gently sloping surrounding ground. The banks were high and steep, which rendered the work of examination rather difficult.

(3) BRESSAY.

Loch of Kirkabister.

(Examined May 15th 1897.)

Examined about 4 p.m., the day being mild and warm. This is a rather small and shallow loch, lying half-way between the beach of Ham and Bressay Lighthouse, and about 48 feet above sea-level. The bottom and sides are boggy, especially the southern shore, which was so soft and spongy as to be unapproachable. Some algæ were growing all round the loch, and fauna seemed plentiful, the hand-net being used round the whole of the loch except the southern shore.

(4) LOCHS IN YELL.

Lochs of Colvister.

(Examined June 4th 1897.)

This large, irregularly-shaped loch was examined about 5 p.m., under favourable atmospheric conditions. The hand-net was used all along the north-eastern shores, which are rocky or gravelly, with very little vegetation. The outlet is by a burn that flows eastwards into Bastavoe. Its altitude is 71 feet.

Loch of Lumbister, Yell.

(Examined June 4th 1897.)

The examination of this loch, which was made between 6 and 7 p.m., was confined to the eastern end, where the shores and bottom are covered with fine red sand. The water is clear, and the loch has a pretty appearance. Very little plant life was visible, and fauna did not seem to be so numerous as in the neighbouring loch of Colvister; but as the loch is a large one, the examination could not be regarded as very complete or satisfactory. It is 64 feet above the level of the sea, and a burn flows westwards from it into Whalfirth.

Maea Water, Yell.

(Examined June 4th 1897.)

Maea Water, which is much smaller and shallower than the two former lochs, lies on a sort of table-land in North Yell, between Bastavoe and Blue Mull Sound. Situated in the middle of a deep moss, its shores are muddy, with occasional stretches of rock or boulders. These facilitated the work of examination, which otherwise would have been difficult.

(5) UNST.

Helliers Water, Unst.

(Examined June 22nd 1897.)

Examined, along with a small neighbouring loch, between 9 and 10 p.m. on the occasion of the Queen's Diamond Jubilee. Helliers Water lies in a very lonely spot in a deep hollow on the hill of Colvidale, which forms part of the more easterly of the two parallel ridges of high land in Unst. It is a deep loch, with stones and gravel about the margin and bottom, and the water is clear and transparent. Very little free-swimming life was observed, and algæ were not abundant, but some mollusca were found about the margin. The small, shallow, clayey loch which was examined at the same time appeared to be more prolific. The gatherings from the two lochs were mixed together.

Helliers Water and a small island near its centre appeared to be frequented by eider ducks, nearly a dozen of which were swimming about during our examination. A large white owl, too, that had perhaps been disturbed by the bonfires and the crowds on the neighbouring hills, kept flitting about, frequently permitting us to get within 40 yards distance.

FAUNISTIC NOTES.

(1) LOCH OF KEBISTER, GREMISTA, LERWICK.

In the note describing some of the physical conditions of this loch, and the circumstances attending the examination of it, reference is made to the purity of the water and to the apparent scarcity in it of animal life. A glance through the gathering of invertebrates collected shows that, on this occasion at least, appearances were not deceptive. The total number of Entomostraca obtained in this gathering was six—four species of Copepoda and two of Cladocera; there were also a few beetles and other insects. Probably if the loch were examined later on in the year, say towards the end of summer, a greater number and variety of invertebrates would be obtained. It is interesting to note that one of the six Crustaceans contained in the gathering was *Diaptomus wierzejskii*, a Copepod rare in the lochs on the mainland of Scotland, but apparently almost ubiquitous in those of Shetland and the Outer Hebrides.

(2) LOCHS IN NORTHMAVINE.

Loch of Flugarth, North Roe.

Thirteen species of Crustacea were obtained in the gathering from this loch comprising eight species of Copepoda, four species of Cladocera, and an Ostracod. *Diaptomus wierzejskii*, which, from its universal distribution in these lochs, might be called the "Shetland *Diaptomus*," was of course present. The somewhat rare *Canthocamptus hirticornis* and *C. minutus* were obtained in this gathering. This is only the second time that *Canthocamptus minutus* has been observed in the lochs of Shetland. *Planorbis nautileus*, *Limnæa peregra*, and a few insects were also noticed.

Loch of Houllsquey, North Roe.

This loch, from its occupying a somewhat peculiar position, might have been expected to yield results more than usually interesting. Unfortunately the parts likely to give the best results could not be reached when the loch was visited. Ten species of Crustacea and a few insects were found in the gathering from this loch of Houllsquey. The "Shetland *Diaptomus*" was again present, and here *Canthocamptus minutus* was also obtained. The Gammarus found was *G. pulex*.

Loch of Benigarth, North Roe.

Although invertebrates were numerous in the gathering from this loch, the variety was not so great as in some of the others: six species of Copepoda, three of Cladocera, two of Ostracoda, and a *Gammarus* (*G. duebeni*) were the Crustaceans obtained. A number of insects were also included in the gathering; these may be identified later on.

Moosa Water, North Roe.

The physical conditions of this loch appear to be unfavourable to the propagation of Entomostraca and other Crustacean species. Lochs with bare rocky or gravelly shores are sometimes very unproductive as regards the micro-invertebrates.

Mill or Ennis Loch.

The gatherings collected here and in Moosa Water were put together in the same bottle, as mentioned in the previous notes: this was done because of the apparent scarcity of living creatures in both gatherings. A careful examination of the contents of this bottle yielded only four species of Crustacea—two of Copepoda and two of Cladocera—and a very few insects. But it is no unusual thing for students of natural history to meet with disappointments, just as other people meet with them in daily life.

Pettidale Water.

In this gathering we again met with the "Shetland *Diaptomus*" (*D. wierzejskii*). Its associates were two species of *Cyclops* (*C. strenuus* and *C. albidus*), one Lynceid (*Alonopsis elongata*), a valve of *Candona candida*, and one or two specimens of *Gammarus pulex*. There were also a few insects in the gathering. This loch, like the two last, is apparently not a favourable habitat for Entomostraca.

Innis Loch.

This completes the series of Northmavine lochs examined last season. Though of small dimensions, Innis Loch gave better results than some of the others. Entomostraca were moderately common in the gathering collected here, and, curiously enough, our *Diaptomus* was not present this time: *Cyclops strenuus* appeared to have taken its place, at least at the time the gathering was collected. A *Cyclops*, whose identity was somewhat doubtful, occurred here, and may form the subject of further study. The total number of species of Crustacea observed in this gathering was thirteen: six of these were Copepods, five Cladocera, and there were two Ostracods.

(3) BRESSAY.

Loch of Kirkabister.

The gathering from this loch was a small lot, but it contained a few things of special interest: mention may be made of three of these. *Cyclops vernalis*, Fischer, has apparently not been previously observed in any gathering from the Shetland lochs. *Canthocamptus cuspidatus*, Schmeil, is a somewhat rare species, for which there are few British records, and it is interesting to find that in our last paper on the Shetland lochs this Copepod is recorded from Setter Loch and Brough Loch, both of which are also in Bressay. *Zaus spinatus*, Goodsir, was another of the Copepods found in this gathering: this, being one of the marine species, seems rather out of its element in the Bressay loch. Of course it was quite possible for this little loch, situated as it is so near the sea, to be a brackish-water loch, and in that case *Zaus spinatus* would not have been so great a "stranger." That it is not a brackish-water loch, however, is fairly evident from the organisms that live in it; and these same organisms are not in ordinary circumstances the associates of *Zaus*. The conclusion of the matter is, that this Copepod, voluntarily or involuntarily, has wandered from its own special haunts into the domicile of strangers. The number of Entomostraca, exclusive of *Zaus*, obtained in the gathering from this loch is eleven—seven Copepods and four Cladocera.

(4) LOCHS IN YELL.

Loch of Colvister.

The gathering from Loch of Colvister contained a greater variety of organisms than that from almost any other of the lochs examined during the season. Cladocera especially were well represented, and included such comparatively rare forms as *Latona setifera*, *Drepanothrix dentata*, and *Harporhynchus falcatus*. Both male and female *Bosmina longirostris* occurred here. The Entomostraca observed included six species of Copepoda and ten species of Cladocera: no Ostracoda were noticed, but there were a few water-mites, "water-boatmen," and insect larvæ.

Loch of Lumbister.

Crustacea were moderately common in this gathering. There was a considerable variety of species, but, with the exception of *Gammarus duebeni*, only two groups—the Copepoda and Cladocera—were represented. The number of species obtained was the same as in the gathering from Loch of Colvister; there was also the same number of Cladocera, but only five species of Copepods. *Latona setifera* was noticed, but appeared to be rare. It sometimes happens that a casual examination of a gathering, when it has just been collected, presents less favourable results than those afterwards obtained. This is due, partly at least, to the tendency of certain organisms, when disturbed, to hide amongst the inorganic and vegetable matter that is more or less unavoidably present in gatherings collected with the hand-net.

Maea Water.

In the gathering from Maea Water nineteen species of Entomostraca were obtained: they comprised seven species of Copepoda and twelve species of Cladocera; no Ostracoda were observed. The somewhat rare *Alona neglecta* occurred here, and was the only thing of special interest observed. *Diaptomus wierzejskii* was more or less frequent in all the three Yell lochs just described.

(5) Unst.

Helliers Water.

The only addition to the Shetland fresh-water fauna obtained during last season was found here. The species alluded to is *Diaptomus castor* (Juriné), and its occurrence in this loch is the more interesting as the only other Scottish record for the species, so far as I can remember, is that published in the 'Annals of Scottish Natural History' for July 1892, p. 202. Moreover, this discovery of *Diaptomus castor* in Helliers Water, Unst, corroborates a remark, in the record in the 'Annals of Scottish Natural History' referred to, as to the probable distribution of the species, viz.:—"This Calanid was formerly considered to be a moderately common species, and as a member of our fauna its distribution was believed to be, and probably is, co-extensive with the British Islands." *Diaptomus wierzejskii* also occurred in this gathering. The total number of species observed was eighteen, and comprised eight species of Copepoda, nine species of Cladocera, and one Ostracod (*Cypria serena*). There were also a few beetles, water-mites, boat-flies, fragments of fresh-water sponge (*Spongilla*), and small rounded masses of a species of *Nostoc*. One of these masses when examined under a cover-glass formed a very pretty miscroscopic object: the moniliform threads, so distinct amidst the transparent mucus, appeared to intertwine in exquisite confusion.

The subjoined Table contains a list of all the species observed in the series of Shetland lochs now described, and their distribution in respect of the various lochs:—

TABLE containing the Names and showing the Distribution of all the Species from the series of Shetland Lochs described in the preceding Notes.

Names of the Species.	District of Lerwick.	Northmavine.						Island of Bressay.	Island of Yell.			Island of Unst.
	Loch of Kebister.	Loch of Flugarth.	Loch of Houllsquey.	Loch of Benigarth.	Moosa Water. Mill or Ennis Loch.	Pettidale Water.	Innis Loch.	Loch of Kirkabister.	Loch of Colvister.	Loch of Lumbister.	Maea Water.	Helliers Water.
MOLLUSCA.												
Pisidium (?) pusillum, Jenyns,		×							×			
Planorbis nautileus (Linné),		×										
Limnæa peregra (Müller), .												×
CRUSTACEA.												
Amphipoda.												
Gammarus duebeni, Lilljeborg, . .				×								
,, *pulex* (Linné), .			×			×				×		

Name of the Species.	District of Lerwick.	Northmavine.						Island of Bressay.	Island of Yell.			Island of Unst
	Loch of Kebister.	Loch of Flugarth.	Loch of Houllsquey.	Loch of Benigarth.	Moosa Water. Mill or Ennis Loch.	Pettidale Water.	Innis Loch.	Loch of Kirkabister.	Loch of Colvister.	Loch of Lumbister.	Maea Water.	Helliers Water.
COPEPODA.												
Diaptomus castor, Juriné, .												×
,, *wierzejskii*, Richard, . .	×	×	×			×			×	×	×	×
Cyclops strenuus, Fischer, .	×	×	×	×	×	×	×	×	×	×	×	×
,, *vernalis*, Fischer, .								×				
,, *albidus* (Juriné), .		×	×	×	×	×				×	×	×
,, *serrulatus*, Fischer, .	×	×	×	×			×		×	×	×	
,, *fimbriatus*, Fischer, .							×	×		×	×	×
,, sp.							×					
Canthocamptus staphylinus (Juriné), .							×	×	×		×	
,, *hirticornis*, T. Scott,		×										
,, *minutus*, Claus, .		×	×									
Attheyella cuspidatus (Schmeil), .								×				
,, *crassa* (G. O. Sars),	×	×	×	×				×				×
,, *pygmæa* (G. O. Sars), . .			×	×			×	×	×		×	×
,, *zchokkei* (Schmeil),		×		×					×			×
Zaus spinatus, Goodsir, .								×				
OSTRACODA.												
Cypria serena (Koch), . .			×	×								×
,, *lævis* (Müller), . .							×					
Cypridopsis villosa (Juriné),		×										
Candona candida (Müller), .				(?)		×	×					
CLADOCERA.												
Latona setifera (Müller), .									×	×		
Drepanothrix dentata (Euren),									×			
Bosmina longirostris (Müller),	×	×		×	×		×	×	×		×	×
Bosmina (?) longispina, Leydig, ...										(?)	×	×
Daphnella brachyura (Lievin),										×		
Daphnia (?) lacustrus (G. O. Sars) . . .								(?)		(?)	(?)	
Eurycercus lamellatus (Müller), ...		×					×		×	×	×	×
Acroperus harpæ, Baird, .									×		×	×
Alonopsis elongata, G. O. Sars, ...			×			×	×		×	×	×	×
Alona affinis, Leydig, . .		×							×	×	×	×
,, *quadrangularis* (Müller), . . .	(?)			×	×		(?)	×	×		×	×
,, *neglecta*, T. Scott, .											×	
Alonella exigua (Lilljeborg).											×	×
Harporhynchus falcatus, G. O. Sars, ...									×	×		
Chydorus sphæricus (Müller),								×		×	×	
,, *barbatus* (Brady), .		×	×	×				×	×		×	×
Polyphemus pediculus (De Geer), ...										×		

X. SOME ADDITIONS TO THE INVERTEBRATE FAUNA OF LOCH FYNE. By Thomas Scott, F.L.S., Mem. Soc. Zool. de France.

(Plates XII., XIII., XIV., XV.)

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INTRODUCTORY REMARKS.

In the paper on "The Marine Fishes and Invertebrates of Loch Fyne," published in Part III. of the Fifteenth Annual Report of the Fishery Board for Scotland, it is distinctly stated that the catalogue then published could "only be considered as preliminary to further research." It would have shown unwarranted presumption on the part of the compiler of that catalogue had he pretended that it could have in any sense been considered exhaustive: it was, as explained in the preliminary remarks, neither more nor less than a compilation from the recorded results of past investigations, so far as these were known to the writer, to which he added certain information that had been obtained as the result of personal study. And though the number of additions that now fall to be made, and the recording of which forms the subject of the present paper, is very considerable, this simply shows that the time when an exhaustive catalogue can be prepared is not yet; and that, notwithstanding all that has already been done, the study of the Loch Fyne invertebrata will yield, for some time to come, profitable and interesting results to the student who has sufficient opportunities and enthusiasm to engage in it.

The species that fall to be recorded in the present paper as additions to the previous catalogue of Loch Fyne invertebrates number in all about one hundred, and include representatives of the following groups:—(1st) The Schizopoda (one species). (2nd) The Isopoda (one species new to Britain). (3rd) The Amphipoda (four species). (4th) The Ostracoda (fourteen species). (5th) The Copepoda (twenty-three species, five of which are apparently undescribed, and two have required new genera to be instituted for them).* (6th) The Annelida (one species, new to the Clyde district). (7th) The Foraminifera (fifty-six species and varieties, or double the number recorded in the first catalogue).

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* In the Appendix there are also descriptions of a new genus and species of Copepoda from Kilbrannan Sound, Firth of Clyde.

I have, as formerly, to acknowledge my indebtedness to several friends for kind assistance in various ways, amongst whom are Prof. G. S. Brady, F.R.S., and Rev. T. R. R. Stebbing, F.R.S.; Dr. G. W. Chaster, of Southport; J. T. Marshall, Torquay; Mrs. Robertson, of Millport; and Fred. G. Pearcey. My son, Mr. Andrew Scott, prepared the series of drawings necessary for the elucidation of new and obscure species.

Since the publication of the catalogue of "The Marine Fishes and Invertebrates of Loch Fyne" no additions have been made to the following groups:—The Fishes, the Tunicata, the Mollusca, the Branchiopoda, the Polyzoa, the Echinoderma, the Actinozoa, the Hydrozoa, and the Spongozoa.

ADDITIONS TO THE CRUSTACEA OF LOCH FYNE.

(1) The Schizopoda.

Erythrops serrata, G. O. Sars. This species was obtained in Upper Loch Fyne at Stations XIII. and XV. *E. serrata* was recorded last year for the first time as a member of the Clyde fauna, from specimens obtained in different parts of the seaward portion of the estuary.

(2) The Isopoda.

Paramunna bilobata, G. O. Sars. This is a small species, but very distinct from any other Isopod recorded from the Clyde. The form of the caudal segment, with its strongly toothed lateral margins, and the bilobed front part of the head, are characteristic. This, which is an addition to the British fauna, was dredged at Otter Spit during last October by F. G. Pearcey, while at work on board the s.s. *Garland.*

(3) The Amphipoda.

Lilljeborgia kinahani (Spence Bate). This Amphipod was obtained amongst some dredged material from Otter Spit, Loch Fyne. Though this is apparently the first record of it in Loch Fyne, it has already been recorded for the Clyde by the late Dr. Robertson, of Millport, under Spence Bate's name of *Phædra kinahani. Lilljeborgia kinahani* need not be mistaken for *L. pallida* (which has also been recorded for the Clyde by Dr. Robertson); not only because it is much smaller, but also because of the distinct difference in the form of the metasome segments.

Podocerus herdmani, Walker. This was obtained in the same gathering as the last, and is apparently not only an addition to the Loch Fyne fauna but also to the Clyde. *P. herdmani* is distinguished chiefly by the peculiar form of the claw of the posterior gnathopods in the male, and without male specimens it is somewhat difficult to differentiate the species. This Amphipod has been recorded from Norway by Prof. G. O. Sars, and its British distribution seems to be extensive, having been observed in the Liverpool district, where it was first discovered by A. O. Walker, the describer of the species, and also in the Firth of Forth.

Podocerus cumbrensis, Stebbing and Robertson. This Amphipod, though previously reported for the Clyde—viz., from the vicinity of the Clach Rock, Cumbrae—has not so far apparently been observed in Loch Fyne.

Specimens of *Podocerus cumbrensis* were obtained in the same Otter Spit gathering with *P. herdmani.* This is a small species, and the armature of the posterior gnathopods in the male varies a good deal; but, so far as I could observe, the males of this Amphipod, notwithstanding the variation referred to, could in every instance be distinguished from *P. herdmani.*

Protella phasma (Montagu). This curious species has been recorded from several parts of the Clyde area by the late Dr. Robertson, and may also have been obtained in Loch Fyne, but I can find no reference to its occurrence in that district amongst the published records within my reach.

(4) THE OSTRACODA.

Bairdia inflata, Norman. This Ostracod was obtained in dredged material from Tarbert Bank, in 20 to 25 fathoms. It has also been obtained from other parts of the Clyde area, but there does not appear to be any previous record of it from Loch Fyne.

Cythere tenera, Brady. I am indebted to Mrs. Robertson, of Millport, for the record of this species from Loch Fyne. It is one of a group of Ostracods usually found in water that is more or less brackish, and is less frequent in the open sea.

Cythere quadridentata, Baird. A few specimens were obtained in material dredged at Tarbert Bank in the spring of last year (1897).

Cythere emaciata, Brady. Was found with the last species. It does not appear to be very rare: the shells, however, were frequently coated with mud, which may cause them at times to be overlooked; but other species—those with rough or spiny tests—found here were, many of them, also more or less covered with mud.

Cythere emarginata (G. O. Sars). Was obtained at Tarbert Bank with the other species mentioned. Mrs. Robertson, of Millport, has also favoured me with a MS. record of the same species for Loch Fyne. It is probable that the Loch Fyne specimens are fossil, as the species, though not rare in some glacial deposits, is apparently, as a recent species, more or less restricted in its distribution to arctic or sub-arctic regions.

Cythere dunelmensis (Norman). This also was obtained at Tarbert Bank. It is probable that *Cythere dunelmensis* is not infrequent in Loch Fyne, as it has a wide distribution—not only generally but throughout the Clyde area; but if the species has previously been obtained in Loch Fyne, it is somewhat inexplicable that Loch Long, Rosneath, and Rothesay Bay should be mentioned as Clyde habitats for the species, while Loch Fyne, which is at least as important a locality as any of these, should be omitted.

Cythere whitei (Baird). This is another of the species obtained at Tarbert Bank, and which may be distinguished by the peculiar sculpture of the shell. It does not appear to be a very common species.

Cytherura simplex, Brady and Norman. I am indebted to Mrs. Robertson, of Millport, for the record of this species for Loch Fyne. A "local variety" of this species had been previously known as *Cytherura sarsi*, but Drs. Brady and Norman, in their recent monograph on this group of Crustaceans, have redescribed and named it as above.

Cytherura clathrata, G. O. Sars. This pretty species was dredged at Tarbert Bank, Loch Fyne. Though generally distributed, it is not very common.

Cytheropteron arcuatum, Brady, Crosskey, and Robertson. I am indebted to Mrs. Robertson for the record of this species. *Cytheropteron arcuatum* was frequent in the post-tertiary clays of Garvel Park, Greenock, and is apparently a true arctic or sub-arctic species ; still, the limits of its distribution may extend beyond these regions.

Cytherois fischeri (G. O. Sars). It is to Mrs. Robertson that I am also indebted for the record of this species. Though *Cytherois fischeri* has not been specifically recorded for Loch Fyne before this time, it is so generally distributed that there are comparatively few marine districts where it may not be found.

Paradoxostoma normani, Brady. I have obtained this very distinct species of *Paradoxostoma* in one or two portions of the Clyde area, including Tarbert Bank, Loch Fyne, but it does not appear to be at all common.

Paradoxostoma ensiforme, Brady. This was one of the more frequent species found at Tarbert Bank, as it also is in other parts of the Clyde.

Paradoxostoma obliquum, G. O. Sars. This, which is comparatively a rare species, was likewise obtained in the material dredged at Tarbert Bank.

(5) THE COPEPODA.

The Copepoda that fall to be recorded at this time include several apparently undescribed forms, and it has also been necessary to institute new genera for two of them ; but before proceeding to record and describe these additions to the Loch Fyne Copepod fauna, I propose to give the following definition of a species previously recorded, which has, along with the others, been the subject of special study. The species referred to was recorded in the former catalogue of Loch Fyne Invertebrata under the name of "(?) *Pseudocalanus armatus*, Boeck," but it has since been removed from the genus *Pseudocalanus* of Boeck to *Bradyidius*, Giesbrecht. The following is a definition of this genus and species :—

Bradyidius armatus (G. S. Brady), (Pl. XII., figs. 1-19).

1878. *Pseudocalanus armatus*, Brady (not Boeck). 'Mon. Copep. Brit. Isl.,' vol. i. p. 46.

1897. *Bradyidius armatus* (Brady), Giesbrecht. 'Zool. Anzeiger,' No. 536.

Description of the female.—Length, 2·54 mm. ($\frac{1}{10}$ of an inch). Body, robust, somewhat resembling *Ætidius armatus* (Brady) in general appearance ; rostrum, distinctly bifid, but not so strongly produced as that of *Ætidius* (figs. 19-20) ; last thoracic segment produced at both sides into strongly-pointed processes; abdomen, small; caudal furca, short (fig. 11); antennules, scarcely reaching to the end of the thorax, and composed of twenty-four joints, the proportional lengths of which are shown by the formula (see also figure 2)—

$$\frac{7 \cdot 6 \cdot 3 \cdot 4 \cdot 4 \cdot 4 \cdot 5 \cdot 6 \cdot 4 \cdot 5 \cdot 5 \cdot 6 \cdot 7 \cdot 7 \cdot 6 \cdot 6 \cdot 6 \cdot 5 \cdot 4 \cdot 4 \cdot 4 \cdot 5 \cdot 5 \cdot 3}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9 \cdot 10 \cdot 11 \cdot 12 \cdot 13 \cdot 14 \cdot 15 \cdot 16 \cdot 17 \cdot 18 \cdot 19 \cdot 20 \cdot 21 \cdot 22 \cdot 23 \cdot 24}$$

The antennæ are somewhat similar to those of *Pseudocalanus elongatus*, but the secondary branches are scarcely so elongate (fig. 3). The mouth-organs and swimming feet are all more or less similar to the same appendages in *Pseudocalanus elongatus* as shown by the figures (figs. 4-10).

Description of the male.—The structure of the male of *Bradyidius* exhibits a greater amount of divergence from that of the nearly-related *Pseudocalanus* than the female does. The number of joints of the male antennule (fig. 12) is twenty-two on the left side, the eighth and tenth joints being each apparently composed of two coalesced joints. The right antennule is similar to the left, except that the seventeenth and eighteenth joints appear to be joined together so as to form only one joint. The proportional lengths of the joints of the left antennule are shown in the formula—

$$\frac{6 \cdot 5 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 7 \cdot 4 \cdot 8 \cdot 5 \cdot 6 \cdot 7 \cdot 2 \cdot 2 \cdot 2 \cdot 6 \cdot 6 \cdot 5 \cdot 6 \cdot 5 \cdot 3}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9 \cdot 10 \cdot 11 \cdot 12 \cdot 13 \cdot 14 \cdot 15 \cdot 16 \cdot 17 \cdot 18 \cdot 19 \cdot 20 \cdot 21 \cdot 22}$$

The mandibles are more or less rudimentary, and they are without the usual apical teeth; they resemble the mandibles of *Pseudocalanus elongatus*, but are not so elongate (fig. 13). The maxillæ are more robust than those of *Pseudocalanus*, and more nearly resemble those of *Ætidius*, but are somewhat dissimilar in certain details of structure and armature, as shown by the figure (fig. 14). The anterior foot-jaws, which are to some extent rudimentary, are considerably stouter than those of *Pseudocalanus*, and the armature of the marginal lobes is peculiarly modified (fig. 15). The fifth pair of thoracic feet differ in structure from both *Pseudocalanus* and *Ætidius*. In *Pseudocalanus* both feet are developed, but each consists of a single branch; in *Ætidius* only one single-branched foot is developed, the other being entirely obsolete; in the present species, which in the structure of the fifth pair more nearly resembles *Ætidius*, one of the single-branched feet is developed, while the other is very rudimentary, but is nevertheless quite distinct, as shown by the figure (fig. 16). Fig. 17 is a drawing of the fifth foot of an immature male.

Habitat.—Firth of Clyde, Loch Fyne, and West Coast; frequent (rare on the East Coast).

Remarks.—This Copepod has occupied our attention for a considerable time. It was felt that it could not be retained in the genus to which it had been ascribed, but, owing to the structural details being somewhat difficult to work out, the study of it was delayed. Last year Dr. W. Giesbrecht, the eminent zoologist of Naples Marine Station, published a preliminary note on the species. He described a few of its more important characters, and at the same time instituted the new genus—*Bradyidius*—for its reception. Previous to that, however, the series of drawings included in the present paper had all been prepared, but the pressure of other work had delayed their publication. We are very pleased that Dr. Giesbrecht has so far settled the question as to the value which should be placed on the structural difference observed in this species, and referred to in the above description, and has given to it a more satisfactory position in the group to which it is related.

Stephos minor, T. Scott. This species, first described from specimens obtained in the Firth of Forth, was observed among some dredged material from Otter Spit. One of the specimens from this locality was a male, the structure of the fifth thoracic feet of which cannot be confounded with any allied form.

Stephos fultoni, T. and A. Scott (Pl. XV. figs. 5-16).

1898. *Stephos fultoni*, T. and A. Scott, 'Ann. and Mag. Nat. Hist.,' ser. 7, vol. i. p. 185, Pl. X., figs. 1-8, and Pl. XI., figs. 1-4.

This fine species, which was first noticed in 1896 amongst some washings of trawl-net refuse from Kilbrannan Sound, has been obtained a second time in a small quantity of dredged material collected in 1897 near Otter Spit, Loch Fyne. *Stephos fultoni* differs from the other two described members of the genus in the fifth thoracic feet in the female being scarcely symmetrical; and it may be remarked that, so far, this Clyde species shows a departure from the normal characters of the genus. The antennules of *Stephos fultoni* (fig. 6) are twenty-four-jointed, and they resemble those of *Stephos minor* in the arrangement of the joints, but the proportional lengths of the joints are rather different (*see* fig. 6). The antennæ and mouth-organs (figs. 7-9) are somewhat similar in structure to those of *Stephos minor*. The second, third, and fourth pairs of swimming feet are proportionally rather more slender and elongate than those of that species. As already stated, the fifth pair in the female (fig. 13) are scarcely symmetrical, the end-joint of the right foot (?) is of a broad, knife-like form, and has the posterior half of the outer margin finely serrated, but the end-joint of the left foot (?) assumes somewhat the form of a "tap-root," being dilated at the base, and then, after suddenly contracting to a small extent, it tapers gradually to the pointed apex.

In the male the chief distinctive feature is the remarkable and powerful development of the fifth thoracic feet (fig. 14). The structure of the left foot is cumbrous and complicated: it terminates in a strongly dilated appendage that is armed with a large and dark-horn-coloured movable claw distinctly bifid at the extremity, while in addition to the claw there are several flexuous appendages of moderate length and stoutness. The right foot is slender, and is somewhat similar to the same foot in *Stephos minor*, but the end-joint is quite different, being curved like a reaping-hook, and with the basal part slightly produced in a direction opposite to that of the hook-like process. It may be noted that the left foot somewhat resembles the same appendage in *Stephos gyrans* (Giesbrecht), but besides other differences *Stephos gyrans* wants the strong bifid claw which gives such a marked character to the left foot of *Stephos fultoni*.

The name adopted for this remarkable species is that of the Superintendent of the Scientific Investigations of the Fishery Board for Scotland—T. Wemyss Fulton, M.D., F.R.S.E.

Pseudocyclopia crassicornis, T. Scott, was dredged in the vicinity of Otter Spit, Upper Loch Fyne. This species, which is moderately frequent in some parts of the Firth of Forth, is apparently less common in the Clyde.

Pseudocyclopia caudata, T. Scott, is smaller than the last species, and is distinguished at first sight by its longer caudal stylets ; it was dredged at Otter Spit with the other.

Ectinosoma erythrops, G. S. Brady, was obtained in the vicinity of Otter Spit. Besides differing in structural details from its congeners, it is furnished with a lateral red eye-spot, to which it owes its name. The eye-spot is situated on the lateral aspect of the cephalic segment, and near the anterior margin. (A second species of *Ectinosoma* with lateral red eye-spots has been described.)

Jonesiella fusiformis, G. S. Brady. A number of specimens of this species were dredged at Tarbert Bank in 1896, but not satisfactorily identified till later. *Jonesiella fusiformis* is rather more slender than *Jonesiella spinulosa*, and with less spinous appendages ; the fifth thoracic feet are also dissimilar.

Pseudotachidius coronatus, gen. et sp. nov. (Pl. XIII., figs. 12-26, and Pl. XV., figs. 1-4).

Description of the female.—Length about ·9mm. ($\frac{1}{28}$ of an inch). Seen from above, the thorax (fig. 22, Pl. XIII.) is moderately broad and sub-cylindrical, the breadth being equal to about three-fifths of the length; abdomen distinctly separate from the thorax, and consisting of five segments; caudal stylets very short. The rostrum is produced, and moderately broad and rounded at the apex, and furnished with two minute apical setæ. The antennules (fig. 23, Pl. XIII.) are six-jointed, very short and stout, and strongly setiferous; the first two joints are subequal, and much larger than any of the others. The formula shows the approximate proportional lengths of the joints—

Proportional lengths of the joints	11	12	6	4	4	5
Numbers of the joints,	1	2	3	4	5	6

The antennæ (fig. 24, Pl. XIII.) are stout and setiferous ; the primary branches are two-jointed, but the secondary branches, which are articulated to the end of the first joint of the primary, are three-jointed, and reach somewhat beyond the extremity of the branches to which they are appended ; the middle joint of the secondary branches is small. The mandibles (fig. 25, Pl. XIII.) are elongate, moderately stout, and have the obliquely truncate apex armed with a series of irregular but moderately stout teeth ; the basal joint of the palp is somewhat dilated, and carries two small setiferous branches ; the inferior branch is composed of two subequal joints, but the superior branch is one-jointed, and slightly longer and stouter than the other branch ; the branches are submarginal on the basal joint, which is also furnished with four moderately stout and plumose apical setæ. The maxillæ (fig. 26, Pl. XIII.) are small but moderately robust; the biting part, which is situated on the lateral aspect of the basal joint, is armed with a few short, stout setæ and elongate, narrow, bifid teeth; immediately posterior to the biting part is a bilobed marginal process, the lobes of which are unequal, the smaller lobe being next to the biting lobe, and both are setiferous; a small supplementary joint bearing three terminal plumose setæ springs at right angles from the base of the bilobed process. Posterior foot-jaws small and two-jointed; the second joint is somewhat dilated, and bears on the inner aspect a series of minute spines, as shown by the drawing (fig. 1, Pl. XV.); a short and stout setiferous spine springs from near the middle of the inner margin, and a stout plumose seta arises from the distal end of the inner margin of the first joint; the terminal claw is moderately stout, but considerably shorter than the joint to which it is articulated. In the first pair of swimming feet (fig. 2, Pl. XV.) both branches are three-jointed; the inner branches, which are elongate, have the first joint longer and considerably stouter than the second and third, being about double the breadth and nearly equal to the entire length of these two joints. The first joint is also furnished on the exterior aspect with one or two obliquely transverse rows of small spines, while a stout seta springs from the distal half of the inner margin; the second and third joints are also each provided interiorly with a marginal seta and with several small spiniform hairs on the outer edge; moreover, the third joint, instead of being armed with a terminal claw, is provided with two stout setæ, one being fully twice the length of the other; the outer branches are small, being little more than half the length of the inner branches; the first joint is rather longer than either the second or third, but the second and third are subequal. The second, third, and fourth pairs have both branches also three-jointed; the inner branches are somewhat shorter than the outer, and both are moderately stout and setiferous (fig. 3, Pl. XV.). The fifth pair (fig. 4, Pl. XV.) are small; the basal joint is of considerable width, but it is short except interiorly, where it is produced into a somewhat conical prolongation that terminates in an elongate and stout seta which is coarsely plumose; a long and stout seta also springs from the exterior angle of the basal joint, as shown by the figure; the secondary joint is very small and subquadrangular, and bears two moderately long setæ—one on each of the interior and exterior angles; intermediate between these are two small spines. No male specimens have been obtained.

Habitat.—Off Skate Island, Lower Loch Fyne, in 105 fms.; rare.

Remarks.—This curious Copepod does not seem to fit with any described genus known to us. In some respects it resembles *Tachidius*—hence the generic name that has been adopted for it; but the combined peculiarities in the structure of the antennules, antennæ, mandibles, and first and fifth pairs of feet do not fit in with the characters of any known genus.

Tetragoniceps consimilis, T. Scott. This species, like *Tetragoniceps bradyi*, has the fifth pair of thoracic feet remarkably broad and leaf-like. It was rare in the dredged material from Otter Spit.

Laophonte longicaudata, Boeck. Was dredged at Otter Spit, but was apparently rare.

Cletodes similis, T. Scott. This species, though moderately small, is robust, and may be distinguished by the form and armature of the first pair of swimming feet; the outer branches and the basal joints to which they are articulated are more or less ciliated. This species was also dredged at Otter Spit.

Dactylopus pectinatus, T. and A. Scott (Pl. XV., figs. 17-24).

1898. *Dactylopus pectinatus*, T. and A. Scott, 'Ann. and Mag. Nat. Hist.,' ser. 7, vol. i. p. 187, Pl. X., figs. 9-16.

This *Dactylopus* somewhat resembles *D. stromii* in general appearance; it is moderately robust, and measures about ·7 mm. ($\frac{1}{36}$ of an inch) in length. *Dactylopus pectinatus* has seven-jointed antennules, the first four joints being stout and subequal, while the other three are comparatively small (see fig. 18, Pl. XV.). The secondary branches of the antennæ are wo-jointed. The mandibles and maxillæ of this species, as well as some other of its structural details, resemble the same parts in *D. rostratus*. The somewhat remarkable characters that chiefly distinguish *Dactylopus pectinatus*, and which suggested the specific name applied to it, are the striking comb-like series of marginal spinules on the terminal claws of the posterior foot-jaws and inner branches of the first pair of swimming feet. This character of the terminal claws referred to, especially those of the inner branches of the first pair of swimming feet, arrested the attention at the time this Copepod was first observed, being readily noticed without resorting to dissection. But besides this peculiar characteristic of the species, it is well that another divergence in the structural details of the same inner branches should also be noticed. These inner branches are apparently only two-jointed, and in this respect differ from the normal structure of *Dactylopus*, and there is also a slight difference in the structure of the outer branches. This difficulty was felt when the species was first described, but as it possessed so many of the characters of a true *Dactylopus* it was considered preferable meanwhile to ascribe it to that genus. No males have been observed.

This species was discovered early in 1896 amongst some refuse trawled between Lowburn and Cairndow, Upper Loch Fyne.

Thalestris peltata (Boeck). Several specimens of this *Thalestris* were obtained amongst some dredged material from the vicinity of Otter Spit. *Thalestris peltata* is so unlike most of the other species of the genus that it may readily be passed over as some other form, but the structure of the mouth organs and of the first pair of swimming feet clearly indicate its relationship with the genus in question.

Thalestris rufocincta, Norman. This species is also from the Otter Spit. The spinous armature of the swimming feet readily characterises this *Thalestris*, which is one of the more common species of the genus.

Harpacticus flexus, Brady and Robertson. This *Harpacticus* was frequent in a gathering of Entomostraca collected in East Loch Tarbert in 1885, but was somehow overlooked until recently. It is a comparatively small species, but quite distinct.

Zaus goodsiri, G. S. Brady. This fine species was obtained at Otter Spit and one or two other places. It appears to be somewhat local, but where it does occur it is not unusual to find it more or less common.

Lichomolgus albens, Thorell, was another of the species found at Otter Spit, and this is also the first time it has been obtained in the Clyde district.

Hermanella arenicola (Brady)—*Lichomolgus arenicolus* (Brady). In this species all the four pairs of swimming feet have both branches three-jointed. It therefore differs from *Lichomolgus* as now restricted, which has the inner branches of the fourth pair only two-jointed. This *Lichomolgus* agrees better with the genus *Hermanella* (Canu), to which I have transferred it meanwhile, than with *Lichomolgus* proper. One or two specimens of this species were found in dredged material from Otter Spit.

Asterocheres echinicola (Norman). This Copepod has been obtained in various parts of Loch Fyne, living in the water-passages of a species of sponge (*Suberites*), and sometimes in considerable numbers.

Asterocheres violaceus (Claus). In dredged material from Otter Spit; apparently rare.

Asterocheres lilljeborgi, Boeck. This fine species has been found in one or two places in the Clyde district. In the previous catalogue of Loch Fyne fauna, male and female of *Artotrogus orbicularis*, Boeck, are recorded from Tarbert Bank, but it has since been ascertained that the supposed male of *Artotrogus orbicularis* was a male specimen of *Asterocheres lilljeborgi*, while the other belonged to *Artotrogus orbicularis;* and this other, which was supposed to be a female, was afterwards found to be a true male. (See *post.*)

(?) *Ascomyzon simulans* sp. n. (Pl. XIII., figs. 1-9, and Pl. XIV., fig. 22).

Description of the female.—Length, 1·1 mm. ($\frac{1}{23}$ of an inch). Body robust; the thoracic segments are laterally rounded off. The abdomen is composed of three segments; the first segment is dilated and twice the length of the next, while the last is rather smaller than the penultimate one; the caudal furca are very small (fig. 1, Pl. XIII.). The antennules are comparatively short and twenty-one jointed. The basal part of the antennules, which is distinctly stouter, consists of eight joints, and all the eight joints are, with the exception of the first, very short; the ninth and tenth are small and contracted; the remaining joints are comparatively slender, and longer than the basal joints, except the last three, which are small (fig. 2, Pl. II.). The formula shows approximately the proportional lengths of all the joints—

$$\frac{15 \cdot 6 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 6 \cdot 2 \cdot 2 \cdot 5 \cdot 8 \cdot 10 \cdot 10 \cdot 9 \cdot 11 \cdot 12 \cdot 14 \cdot 5 \cdot 4 \cdot 3}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9 \cdot 10 \cdot 11 \cdot 12 \cdot 13 \cdot 14 \cdot 15 \cdot 16 \cdot 17 \cdot 18 \cdot 19 \cdot 20 \cdot 21}$$

The secondary branches of the antennæ are very small, and furnished with two minute setæ (fig. 3, Pl. XIII.). The mandibles are long, slender, and pointed at the apex, and are armed at the extremity with several minute lateral teeth; the palp is slender, and rather more than a third of the length of the mandible; it is two-jointed, the end-joint shorter than the other, and furnished with two slightly plumose setæ (fig. 4, Pl. XIII.). The maxillæ are moderately large, and the one lobe is scarcely half the length of the other; both are provided with several long plumose hairs (fig. 5, Pl. XIII.). The foot-jaws are as in *Cyclopicera* (figs. 6, 7, Pl. V.). Both branches of all the swimming feet are three-jointed. The setæ of the last joint of the outer branches number 4 · 4 · 4 · 4 ·, and of the last joint of the inner 6 · 6 ·(?) 6 · 4 ·; the marginal branches of the outer spines are small, but the terminal spines of both branches, where present, are broad and sabre-like (figs. 8-9, Pl. XIII.). The fifth pair are broadly ovate, and have three apical setæ (fig. 22, Pl. XV.). Male unknown.

Habitat.—Kilbrannan Sound, 1886; Otter Spit, Loch Fyne, 1887.

Remarks.—This Copepod, though closely allied to *Ascomyzon*, differs in one or two points from the characters which distinguish that genus. The mandible palp is comparatively short, and the hairs of the mandible palp and maxillæ are plumose. The number of setæ on the last joint of the outer and inner branches of the swimming feet is probably also dissimilar, but otherwise it appears to agree with the genus to which it is, for the present, ascribed.

Neopontius angularis, gen. et sp. n. (Pl. XIV., figs. 1-11).

Description of the female.—Length, 1·36 mm ($\frac{1}{19}$ of an inch). The thorax, seen from above, is moderately broad and sub-angular, the third and fourth segments are produced laterally and posteriorly almost to the distal end of the narrow fifth segment, causing the posterior part of the thorax to terminate somewhat abruptly; the forehead is also broadly rounded. The abdomen is long and slender, and composed of four segments; the anterior portion of the genital segment is scarcely broader than it is posteriorly; this segment is fully equal to the combined length of the next three. The caudal stylets are elongate and comparatively broad; they are rather longer than the last two abdominal segments (fig. 1). The antennules are short and twelve-jointed; the first two and last joints are longer than the others; the third to the sixth are very short, while the last four joints are distinctly narrower than the basal joint; the æsthetask springs from the end of the last joint (fig. 2). The formula shows the proportional length of the joints—

$$\frac{27 \cdot 27 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 10 \cdot 8 \cdot 18 \cdot 12 \cdot 15 \cdot 30}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9 \cdot 10 \cdot 11 \cdot 12}$$

The antennæ are small, and the secondary branches consist of a single small joint, having two minute hairs (fig. 3). The mandibles are stylet shaped, being very long and slender; there appears to be an intermediate joint, but somewhat nearer the distal than the proximal end; the mandibles are also armed with a few minute lateral teeth that extend a short distance back from the apex (fig. 4). The maxillæ are moderately large; the principal branch is cylindrical and about four times longer than broad, the other is narrower and slightly tapering and equal to about two-thirds of the length of the larger; the smaller branch is provided with three, the larger with four plumose setæ (fig. 5). The foot-jaws somewhat resemble those of *Dispontius*, but the claws of the anterior pair are strong and powerful, and have a stout seta on the inner aspect, also a small spine exteriorly (fig. 6); the claws of the posterior pair are more slender (fig. 7). All four pairs of swimming feet have both branches three-jointed; the inner branches of the first pair have no terminal spines; the marginal spines of the outer branches are short and stout; the end-joint of the inner branches has three setæ on the inner margin, two at the apex, and one on the outer margin, while the end-joint of the outer branches has four setæ round the inner margin and apex (fig. 8). In the fourth pair both branches are armed with broad, sword-like spines; the inner branches are rather narrower than the outer, and the last joint bears two setæ on the inner margin and one on the outer margin; there is also a small supplementary apical seta; the end-joint of the outer branches is provided with five setæ on the inner margin (fig. 9). Fifth pair of feet moderately large, sub-quadrate in outline, the outer margin straight, inner margin curved from the somewhat narrow basal part to the broad truncate extremity of the foot, where it terminates in a small thumb-like process; two setæ spring from the truncate apex and one from the lateral aspect of the distal half; an elongate seta also springs from the outer angles of the thoracic segment to which the fifth pair are attached (fig. 10).

Description of the male.—The male appears to be similar to the female in every respect except in the structure of the antennules, and even in this respect the difference is not apparently very great. The male antennules are twelve-jointed, the proportional lengths of the first eight being similar to those of the female; the ninth is considerably longer than the same joint in the female antennule, while it is also of a different form, and carries a long, stout seta at the distal extremity; the last joint is shorter than the same joint in the female antennule, and is hinged to the preceding joint (fig. 11).

Habitat.—Otter Spit, Loch Fyne.

Remarks.—Two or three specimens of this somewhat curious species were obtained in a gathering of micro-crustacea sent to me from Loch Fyne by F. G. Pearcey, of the Fishery Board. It seems undoubtedly to belong to the sub-family of Dyspontiinæ of Dr. Giesbrecht, but I am unable to place it under any of the described genera of that group. It has certain points of resemblance with *Myzopontius*, but the structure of the mouth organs excludes it from that genus. Meanwhile I have decided to institute a new genus for its reception, and as there is but one species, the description includes both the generic and specific characters.

Artotrogus orbicularis, Boeck (Pl. XIV., figs. 12-21).

Description of the male.—Length, 1·34 mm. ($\frac{2}{37}$ of an inch). Seen from above, the thorax is almost circular, being about as broad as it is long; the segments are somewhat produced laterally into angular processes. The abdomen is small and apparently only (?) three-jointed, the first two being very short. Caudal stylets short and broad (fig. 12). The antennules are short, and eight-jointed; the first and second joints are large, the others smaller; an æsthetask springs from the end of the last joint (fig. 13). The proportional lengths of the joints are shown by the formula—

$$\frac{24 \cdot 23 \cdot 9 \cdot 5 \cdot 9 \cdot 6 \cdot 7 \cdot 15}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8}$$

Antennæ three-jointed and bearing three terminal hairs; secondary branches very small (fig. 14). Maxillæ large, lobes unequal, outer lobes elongate, broad at the base, but tapering gradually to the narrow apex, from which springs a long, moderately stout, and slightly plumose seta; inner lobe about half the length of the other, and bearing three terminal setæ, two of which are long and moderately stout and one small (fig. 15). The anterior foot-jaws are provided with moderately short but stout and strongly-curved claws (fig. 16). The posterior foot-jaws are also armed with stout, though short, terminal claws, the structure of which resembles generally those of the same appendages in other species of Ascomyzontidæ (fig. 17). The first and second pairs of swimming feet are large, and both branches are three-jointed; in the first pair the marginal spines are small but stout, there are no terminal spines on either the outer or inner branches ; the end-joint of the outer branches bears five setæ round the inner margin and apex, so does the end-joint of the inner branches, but this joint bears a seta also on the outer margin (fig. 18). The second pair are somewhat larger than the first, and the outer branches are armed with a terminal spine. The third pair are similar to the second ; in both, the end-joints of the outer branches are provided with five setæ on the inner margin and apex ; the end-joints of the inner branches bear also five setæ as shown by the figure (fig. 19) ; the fourth pair appear to be entirely absent. The fifth pair are rudimentary, and consist of a slightly produced and rounded portion of the thoracic segment furnished with three short and stout plumose hairs (fig. 20). The appendages to the first abdominal segment resemble the fifth pair of thoracic very nearly, and are provided with a similar number of setæ (fig. 21).

Habitat.—Tarbert Bank, Loch Fyne ; very rare.

Remarks.—In the paper on the "Marine Fishes and Invertebrates of Loch Fyne," published in the Fifteenth Annual Report of the Fishery Board for Scotland, a male and a female of *Artotrogus orbicularis* are recorded from Tarbert Bank. The supposed male has since been ascertained to belong to another genus, *Asterocheres* (see the record under that name), while the supposed female was really a male as described above. The only British specimen of a female known to me is that obtained by I. C. Thompson, of Liverpool, in the Irish Sea. The remarkable circular form of this species is very characteristic.

ADDITION TO THE VERMES OF LOCH FYNE.

Panthalis oerstedi, Kinberg. This annelid has lately been obtained in Loch Fyne by Mr. F. G. Pearcey, of the Fishery Board. Unable at first to identify the annelide that had gathered around itself such a huge, unsightly mass of slimy mud, I afterwards remembered having had the privilege of listening to a very interesting description by Professor Herdman of the habits of *Panthalis oerstedi*, and of the interesting researches of Arnold T. Watson, of Sheffield, who had so successfully settled the question that had been raised as to whether this annelid formed its own tube or not, and concluded that this also was *Panthalis.* The surmise proved correct, and I am therefore now able to make this interesting addition to the Loch Fyne fauna. The patient and successful researches of Arnold T. Watson are fully described in a paper published by him in the Transactions of the Liverpool Biological Society for 1894-95. The species seems to be restricted in its distribution to water of considerable depth, and with a bottom of fine mud.

ADDITIONS TO THE FORAMINIFERA OF LOCH FYNE.

A large number of additional records of Loch Fyne Foraminifera have been obtained since the publication of the previous list. I am indebted for several of these to Mrs. Robertson, of Millport, and to Mr. F. G. Pearcey, of the Fishery Board. Dr. G. W. Chaster, of Southport, has also aided me with this group. The species are arranged as in the previous paper.

Miliolidæ.

Spiroloculina planulata (Lamk.). Loch Fyne (Mrs. Robertson).

Miliolina oblonga (Montagu) = (*Triloculina oblonga*). Dredged at Tarbert Bank, 20 to 25 fms.

Miliolina auberiana (d'Orb). Loch Fyne (Mrs. Robertson). Dredged at Tarbert Bank, Loch Fyne, 20 to 25 fms.

Miliolina venusta (Karrer). Loch Fyne (Mrs. Robertson).

Miliolina bicornis (W. and T.). Loch Fyne (Mrs. Robertson). Dredged at Tarbert Bank in 20 to 25 fms.

Miliolina labiosa, d'Orb. Loch Fyne (Mrs. Robertson).

Miliolina fusca, Brady. Dredged at Tarbert Bank, Lower Loch Fyne; rare.

Sigmoilina tenuis, Czjzek. Dredged at Tarbert Bank; rare.

Cornuspira involvens, Reuss. Off East Loch Tarbert, Lower Loch Fyne; rare (collected 1886).

Astrorhizidæ.

Pelosina variabilis, H. B. Brady. Common below Inveraray in 70 fms. (Mrs. Robertson). F. G. Pearcey has also dredged this large and curious species in Loch Fyne. It is so large and unlike the organisms usually known as Foraminifera that the test may be passed over as a worm-tube of some kind.

Hyperammina arborescens, Norman. Loch Fyne (Mrs. Robertson). This is found attached to stones and the "roots" of sea-weeds, and though comparatively large it is necessary to have some familiarity with the group to which it belongs to be able to recognise it.

Tecnitella legumen, Norman. Loch Fyne (Mrs. Robertson). This is another peculiar species, and very unlike the usual Foraminifer.

Dendrophrya radiata, Strethil Wright. Ardlamont Point, at low spring tides (F. G. Pearcey).

Dendrophrya erecta, Strethil Wright. Ardlamont Point, at low spring tides, along with the other (F. G. Pearcey). These two interesting species of Foraminifera were found by Dr. Strethil Wright in Granton Quarry, and described by him in 1861 in the 'Annals and Magazine of Natural History.' *D. erecta* was afterwards found in the same quarry by the late Dr. Robertson, who also many years ago discovered both species in low-tide pools at Cumbrae.

Lituolidæ.

Reophax fusiformis (Williamson). Dredged at Tarbert Bank, in 20 to 25 fms.

Reophax deflugiformis, H. B. Brady. Dredged at Tarbert Bank.

Reophax moniliforme, Siddall. Dredged also at Tarbert Bank.

Reophax scottii, Chaster. East Loch Tarbert, 1886. The test of this species is slender and elongate, and composed of a considerable number of segments that become gradually larger; it is more or less flexible when moist. *Reophax scottii* is generally distributed in Upper Loch Fyne, in East Loch Tarbert, in Campbeltown Loch, and other parts of the Clyde area. It is also sparingly distributed throughout most of the estuary of the Forth, as well as in other places around the British coasts.

Ammodiscus charoides (Jones and Parker). This pretty species, which is of a brown colour, and somewhat resembling a seed capsule or "nucule" of *Chara*, but with the surface polished, was dredged at Tarbert Bank. It seems to be very rare in Loch Fyne.

Ammodiscus shoneanus, Siddal. Loch Fyne (Mrs. Robertson).

Trochammina inflata (Montagu). Off Skate Island, 105 fms.; very rare (F. G. Pearcey). Off Inveraray; rare (Dr. Robertson, in 'Notes on the Fauna and Flora of the West of Scotland,' p. 51).

Trochammina inflata var. *macrascens*, H. B. Brady. Loch Fyne; very rare (Mrs. Robertson).

Trochammina plicata, Terquem. Lower Loch Fyne, off East Tarbert; rare (collected 1886).

Trochammina robertsoni, H. B. Brady. Loch Fyne (Mrs. Robertson). I have also dredged this species at Tarbert Bank, but it appears to be rare in Loch Fyne.

Valvulina austriaca, d'Orb. Off Inveraray, Upper Loch Fyne; rare (Dr. Robertson, in 'Notes on the Fauna and Flora of the West of Scotland,' p. 51).

Textularidæ.

Textularia trochus, d'Orb. Dredged at Tarbert Bank; not common.

Textularia gramen, d'Orb. Dredged at Tarbert Bank; moderately frequent.

Verneuilina polystropha (Reuss). Loch Fyne (Mrs. Robertson). Off Skate Island, 105 fms. (F. G. Pearcey). I have also dredged this species at Tarbert Bank.

Sagrina dimorpha. Dredged at Tarbert Bank; rare.

Bulimina elegantissima, d'Orb. Off Minard Castle, in 28 fms. (F. G. Pearcey).

Virgulina schreibersiana, Ezjzek. Loch Fyne (Mrs. Robertson).

Bolivina punctata, d'Orb. Off Inveraray, Upper Loch Fyne; rare (Dr. Robertson, in 'Notes on the Fauna and Flora of the West of Scotland,' p. 52).

Bolivina plicata, d'Orb. Loch Fyne (Mrs. Robertson). I have dredged this species also at Tarbert Bank.

Bolivina dilatata, Reuss. Dredged at Tarbert Bank; not very rare.

Bolivina lævigata (Williamson). Off Minard Castle, Upper Loch Fyne, in 28 fms. (F. G. Pearcey).

Cassidulina crassa, d'Orb. Off East Loch Tarbert, Lower Loch Fyne (collected 1886).

Lagenidæ.

Lagena lævis var. *clavata*, d'Orb. Dredged at Tarbert Bank, Lower Loch Fyne.

Lagena lineata (Williamson). Off Minard Castle, Upper Loch Fyne, in 28 fms. (F. G. Pearcey).

Lagena williamsoni, Alcock. Dredged at Tarbert Bank, Lower Loch Fyne.

Lagena costata, Williamson. Dredged at Tarbert Bank with the other.

Lagena gracilis, Williamson. Off Skate Island, in 105 fms.; rare (F. G. Pearcey).

Lagena semistriata, Williamson. Loch Fyne (Mrs. Robertson).

Lagena lævigata var. *lucida*, Williamson. Dredged at Tarbert Bank, Lower Loch Fyne.

Lagena lyelli, Sequenza. Dredged also at Tarbert Bank.

Lagena orbignyana, Sequenza. This also was dredged at Tarbert Bank.

Lagena lagenoides, Williamson. Off Skate Island, in 105 fms. (F. G. Pearcey).

Nodisaria pyrula, d'Orbigny. Dredged at Tarbert Bank, Lower Loch Fyne.

Nodosaria obliqua, Linné. Dredged also at Tarbert Bank; apparently a rare species.

Nodosaria perversa, Schw. Dredged at Tarbert Bank; rare.

Nodosaria (*Dentalina*) *pauperata* (d'Orbigny). Off Inveraray, Loch Fyne; rare (Dr. Robertson, in 'Notes on the Fauna and Flora of the West of Scotland,' p. 52).

Vaginulina legumen, Linné. Dredged at Tarbert Bank; rare.

Marginulina glabra, d'Orbigny. Dredged at Tarbert Bank; rare.

Polymorphina oblonga, d'Orbigny. Off Skate Island, in 105 fms.; very rare (F. G. Pearcey). Dredged also at Tarbert Bank.

Polymorphina lanceolata, Reuss. Loch Fyne (Mrs. Robertson).

Polymorphina compressa, d'Orbigny. Loch Fyne (Mrs. Robertson).

Polymorphina sororia, Reuss. Loch Fyne (Mrs. Robertson). Dredged also off East Loch Tarbert.

Polymorphina sororia var. *cuspidata*. Loch Fyne (Mrs. Robertson).

Uvigerina angulosa, Williamson. Dredged at Tarbert Bank, Lower Loch Fyne; rare.

Discorbina orbicularis, Terquem. Off East Loch Tarbert, 20 fms. (F. G. Pearcey).

Truncatulina ungeriana, d'Orb. East Loch Tarbert (collected 1886); rare.

Pulvinulina auricula, Fichtel and Moll. Dredged at Tarbert Bank, Lower Loch Fyne; rare.

Nonionina orbicularis, H. B. Brady. Loch Fyne (Mrs. Robertson).

Nonionina scapha, Fichtel and Moll. Loch Fyne (Mrs. Robertson). Dredged also at Tarbert Bank; rare.

The species and varieties of Foraminifera recorded in the preceding notes number 56, which, including those recorded in the previous list, brings up the total number to 111.

APPENDIX.—EXTRA NOTES ON SOME CLYDE CRUSTACEA.

Addition to the Amphipoda of the Firth of Clyde.

Dulichia monocantha, G. O. Sars. I have on one or two occasions observed specimens of what appeared to be *Dulichia monocantha*, but as the specimens were females their identification was somewhat doubtful, the females being much more difficult to differentiate than the males. Last summer, however, Mr. F. G. Pearcey forwarded to me the contents of a haddock's stomach from the Clyde, and while looking through this material I obtained a male specimen of this *Dulichia*. Though there may be doubt as to the correct identification of female specimens of this species, there need be none as regards male specimens, the strongly-marked character of the first pair of coxal plates in the male being quite sufficient to identify the species. This species appears to be new to Britain.

ADDITIONS TO THE COPEPODA OF THE FIRTH OF CLYDE.

Scottocheres elongatus (T. and A. Scott), (Pl. XIII., figs. 10-21).

1894. *Acontiophorus elongatus*, T. and A. Scott, 'Ann. and Mag. Nat. Hist.,' ser. 6, vol. xii. p. 145, Pl. IX., figs. 15-20; and T. Scott, Twelfth Ann. Rep. Fish. Board, Scot., Part III., p. 261.

1897. *Scottocheres elongatus*, W. Giesbrecht, 'Zool. Anzeig.,' Nos. 521, 522 (separate copy), p. 6.

This Copepod was partly described by Thomas and Andrew Scott in 1894 from one or two specimens obtained in the Firth of Forth. It was ascribed to *Acontiophorus*, Brady, as that was the genus to which it was apparently most closely related. Since that time Dr. Giesbrecht, the eminent crustaceologist of the Naples Zoological Station, has made a special study of this family of the Copepoda, and introduced certain necessary changes in the arrangement and nomenclature of the various genera and species comprised in it. One of these changes is the institution of a new genus for this Copepod, viz., *Scottocheres*—as indicated above. It is interesting to note that Dr. Giesbrecht has discovered *Scottocheres elongatus* in the vicinity of Naples. Till comparatively recently this species was known to me only from the Firth of Forth, but I am now able to record it also from the Clyde, a specimen of it having been obtained in the vicinity of Sanda Island. Its discovery in the Clyde enables me to give a fuller description of the species, and also figures showing additional structural details, as follow:—

An ova-bearing female has been figured by my son, and is represented in fig. 10. This specimen measured almost a millimetre in length, and carried two ovisacs, each apparently containing three large ova. The antennules are comparatively short, and are seventeen-jointed; but the eighth joint, counting from the base, ought, perhaps, to be reckoned two joints, as an indistinct suture is seen extending partly across it. The last joint is longer than any of the others except the basal joint, and an æsthetask springs from the end of the second-last joint (fig. 11). The antennæ are slender and three-jointed, but the last joint is very small and bears a moderately long claw-like spine; the secondary branches are also very small, and one-jointed (fig. 12). The mandibles are very long and very slender, being about as long as the siphon, which reaches to near the end of the cephalothorax (figs. 13, 14). The maxillæ are small and two-branched; one branch is stout and somewhat conical in shape, the other is small and somewhat cylindrical; both branches bear three setæ, two of the setæ of the larger branch being of considerable length and plumose (fig. 15). The foot-jaws are elongate and slender, and both pairs have moderately long terminal claws; the anterior pair are two-jointed, but the posterior pair are apparently four-jointed, as shown by the figures (figs. 16, 17). All the four pairs of swimming feet have both branches three-jointed (figs. 18 and 19 represent the first and fourth pairs); the fifth pair are broadly elliptical, and bear three terminal setæ (fig. 20). The abdomen consists of three segments; the genital segment is large, while the third is shorter than the penultimate one; caudal stylets very short (fig. 21). We have not yet observed the male of this Copepod.

Eurynotus insolens, T. and A. Scott (Pl. XV., figs. 25-34).
1898. *Eurynotus insolens*, T. and A. Scott, 'Ann. and Mag. Nat. Hist.,' ser. 7, vol. i. p. 188, Pl. X., fig. 17; and Pl. XI., figs. 5-13.

This curious parasite—for that it is parasitic on some creature is evident by the structure of the mouth-organs—was discovered among some trawled refuse from Kilbrannan Sound, Firth of Clyde, in 1886. The thorax is broad and somewhat ovate, it is large in comparison with the abdomen, and seen from above is indistinctly divided into two segments, the junction of which is indicated by a slight constriction on each side (fig. 25). The antennules (fig. 26) are short and seven-jointed, and taper gradually from the moderately stout base; the second joint is much longer than any of the others, and bears a long plumose seta at the distal end of the lower margin. The antennæ (fig. 27) are stout, and apparently four-jointed, and furnished with a series of peculiar terminal hairs, some of which are distinctly hooked at the ends, and two of them terminate in what seem to be circular disks, as shown by the figure; the antennæ do not appear to possess secondary appendages. The mandibles (fig. 28) are simple, elongate, and slender organs, which terminate in hook-like extremities; they are each provided with two long marginal setæ near the middle (figs. 29 and 30 show the rudimentary structure of the maxillæ and anterior foot-jaws). The posterior foot-jaws (fig. 31) appear to be two-jointed; the first joint is dilated interiorly so as to assume a somewhat gibbous form, and a considerable portion of the gibbous surface is clothed with minute spines; the end-joint is very small, and bears three terminal setæ of unequal length. There are only three pairs of thoracic feet, the fourth and fifth being apparently obsolete; and while the first and second pairs are both three-branched, the third pair appears to be only one-branched (figs. 32, 33). There is a large and prominent circular disk-like appendage situated between and a little in front of the mandibles; this appendage is probably used by the Copepod as a sucker for adhering to the creatures that form its host. The male is so far unknown. *Eurynotus insolens* appears to be a rare species. The generic name—*Eurynotus*—which has been given to this Copepod was suggested by the broadly ovate form of the thorax, *eurynotus* being a slightly modified form of the Greek word signifying "having broad shoulders."

CHONIOSTOMATIDÆ.

Aspidœcia normani, Giard and Bonnier. Last year I recorded the curious *Erythrops* parasite *Aspidophryxus peltatus* from the Clyde. I have now to report the occurrence in the Clyde of another curious parasite of *Erythrops*—viz.., *Aspidœcia normani*. I have on one or two previous occasions observed what looked like rounded tubercles on the back and sides of odd specimens of these Schizopods without knowing what they were. A perusal of Dr. H. J. Hansen's monograph of the *Choniostomatidæ*, however, showed at once their true character.

In concluding these notes, I may state that there are one or two crustacean species still unidentified, and that have consequently to stand over for the present.

DESCRIPTION OF THE PLATES.

Plate XII.

Bradyidius armatus (Brady).

Fig. 1.	Female—dorsal view,	× 26½	diameters.
Fig. 2.	Antennule of female,	× 40	,,
Fig. 3.	Antenna,	× 95	,,
Fig. 4.	Mandible and palp of female,	× 63	,,
Fig. 5.	Maxilla of female,	× 126	,,
Fig. 6.	Anterior foot-jaw of female,	× 190	,,
Fig. 7.	Posterior foot-jaw,	× 84	,,
Fig. 8.	Foot of first pair of swimming feet,	× 126	,,
Fig. 9.	Foot of second pair of swimming feet, female,	× 84	,,
Fig. 10.	Foot of fourth pair of swimming feet, female,	× 84	,,
Fig. 11.	Last thoracic segment and abdomen, female,	× 35	,,
Fig. 12.	Antennule of male,	× 54	,,
Fig. 13.	Mandible and palp of male,	× 126	,,
Fig. 14.	Maxilla of male,	× 190	,,
Fig. 15.	Anterior foot-jaw of male,	× 500	,,
Fig. 16.	Fifth pair of feet of male,	× 26	,,
Fig. 17.	Fifth pair of feet of male (immature),	× 90	,,
Fig. 18.	Abdomen of male,	× 64	,,
Fig. 19.	Rostrum,	× 380	,,

Ætidius armatus, Brady.

Fig. 20.	Rostrum (for comparing with that of *Bradyidius*),	× 300	diameters.

Plate XIII.

(?) *Ascomyzon simulans*, sp. n.

Fig. 1.	Female—dorsal view,	× 53	diameters.
Fig. 2.	Antennule of female,	× 190	,,
Fig. 3.	Antenna,	× 190	,,
Fig. 4.	Mandible and palp,	× 253	,,
Fig. 5.	Maxilla,	× 253	,,
Fig. 6.	Anterior foot-jaw,	× 190	,,
Fig. 7.	Posterior foot-jaw,	× 190	,,
Fig. 8.	Foot of second pair of swimming feet,	× 152	,,
Fig. 9.	Foot of fourth pair of swimming feet,	× 152	,,

Scottocheres elongatus (T. and A. Scott).

Fig. 10.	Female, with ova—dorsal view,	× 70	diameters.
Fig. 11.	Antennule of female,	× 253	,,
Fig. 12.	Antenna,	× 253	,,
Fig. 13.	Mandible,	× 190	,,
Fig. 14.	Siphon,	× 190	,,
Fig. 15.	Maxilla,	× 337	,,
Fig. 16.	Anterior foot-jaw,	× 253	,,
Fig. 17.	Posterior foot-jaw,	× 253	,,
Fig. 18.	Foot of first pair of swimming feet,	× 253	,,
Fig. 19.	Foot of fourth pair of swimming feet,	× 253	,,
Fig. 20.	Foot of fifth pair,	× 380	,,
Fig. 21.	Abdomen and caudal stylets,	× 160	,,

Pseudotachidius coronatus, gen. et sp. nov.

Fig. 22.	Female—dorsal view,	× 80	diameters.
Fig. 23.	Antennule of female,	× 253	,,
Fig. 24.	Antenna,	× 380	,,
Fig. 25.	Mandible and palp,	× 253	,,
Fig. 26.	Maxilla,	× 253	,,

PLATE XIV.

Neopontius angularis, gen. et sp. nov.

Fig. 1.	Female—dorsal view,	× 53	diameters.
Fig. 2.	Antennule of female,	× 190	,,
Fig. 3.	Antenna,	× 253	,,
Fig. 4.	Mandible,	× 253	,,
Fig. 5.	Maxilla,	× 506	,,
Fig. 6.	Anterior foot-jaw,	× 253	,,
Fig. 7.	Posterior foot-jaw,	× 253	,,
Fig. 8.	Foot of first pair of swimming feet,	× 190	,,
Fig. 9.	Foot of fourth pair of swimming feet,	× 190	,,
Fig. 10.	Foot of fifth pair,	× 380	,,
Fig. 11.	Attenule of male,	× 190	,,

Artotrogus orbicularis, Boeck.

Fig. 12.	Male—dorsal view,	× 40	diameters.
Fig. 13.	Antennule of male,	× 190	,,
Fig. 14.	Antenna,	× 190	,,
Fig. 15.	Maxilla,	× 253	,,
Fig. 16.	Anterior of foot-jaw,	× 80	,,
Fig. 17.	Posterior foot-jaw,	× 106	,,
Fig. 18.	Foot of first pair of swimming feet,	× 190	,,
Fig. 19.	Foot of third pair of swimming feet,	× 190	,,
Fig. 20.	Foot of fifth pair,	× 380	,,
Fig. 21.	One of the appendages of the first abdominal segment,	× 380	,,

(?) *Ascomyzon simulans*, sp. n.

Fig. 22.	Foot of fifth pair,	× 380	diameters.

PLATE XV.

Pseudotachidius coronatus, g. et sp. n.

Fig. 1.	Posterior foot-jaw,	× 380	diameters.
Fig. 2.	Foot of first pair of swimming feet,	× 190	,,
Fig. 3.	Foot of fourth pair of swimming feet,	× 190	,,
Fig. 4.	Foot of fifth pair,	× 380	,,

Stephos fultoni, T. and A. Scott.

Fig. 5.	Female—lateral view,	× 53	diameters.
Fig. 6.	Antennule of female,	× 80	,,
Fig. 7.	Antenna,	× 126	,,
Fig. 8.	Mandible and palp,	× 94	,,
Fig. 9.	Posterior foot-jaw,	× 190	,,
Fig. 10.	Foot of first pair of swimming feet,	× 167	,,
Fig. 11.	Foot of second pair of swimming feet,	× 125	,,
Fig. 12.	Foot of fourth pair of swimming feet,	× 125	,,
Fig. 13.	Foot of fifth pair—female,	× 300	,,
Fig. 14.	Foot of fifth pair—male,	× 253	,,
Fig. 15.	Abdomen and caudal stylets of female,	× 80	,,
Fig. 16.	Abdomen and caudal stylets of male,	× 80	,,

Dactylopus pectinatus, T. and A. Scott.

Fig. 17.	Female—dorsal view,	× 80	diameters.
Fig. 18.	Antennule of female,	× 253	,,
Fig. 19.	Antenna,	× 300	,,
Fig. 20.	Anterior foot-jaw,	× 300	,,
Fig. 21.	Posterior foot-jaw,	× 380	,,
Fig. 22.	Foot of first pair of swimming feet,	× 253	,,
Fig. 23.	Foot of fourth pair of swimming feet,	× 200	,,
Fig. 24.	Foot of fifth pair—female,	× 380	,,

Eurynotus insolens (T. and A. Scott).

Fig. 25.	Female—dorsal view,	× 80	diameters.
Fig. 26.	Antennule of female,	× 253	,,
Fig. 27.	Antenna	× 300	,,
Fig. 28.	Mandible,	× 380	,,
Fig. 29.	Maxilla,	× 760	,,
Fig. 30.	Anterior foot-jaw,	× 300	,,
Fig. 31.	Posterior foot-jaw,	× 380	,,
Fig. 32.	Foot of first pair of swimming feet,	× 300	,,
Fig. 33.	Foot of third pair of swimming feet,	× 380	,,
Fig. 34.	Sucker-disk,	× 200	,,

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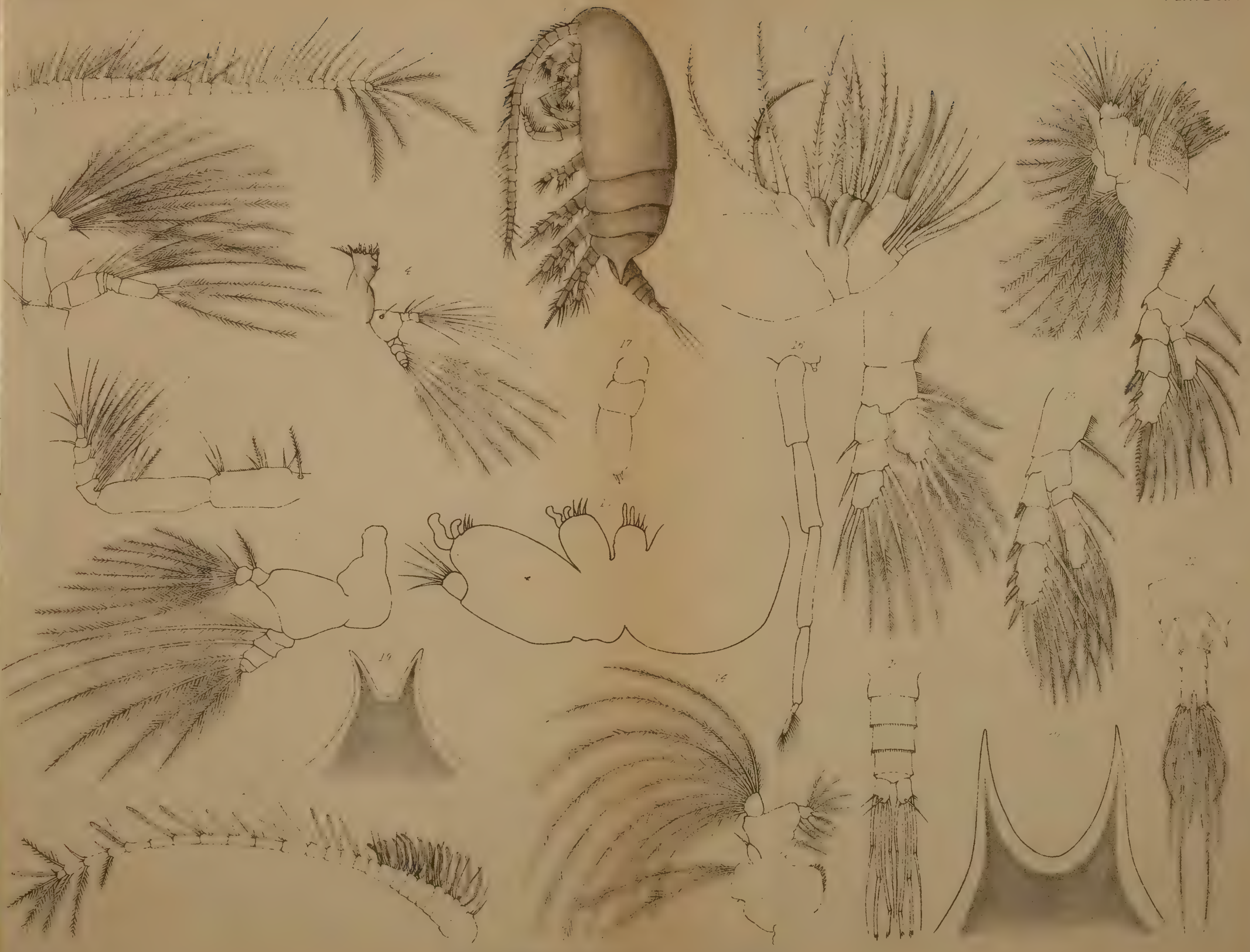
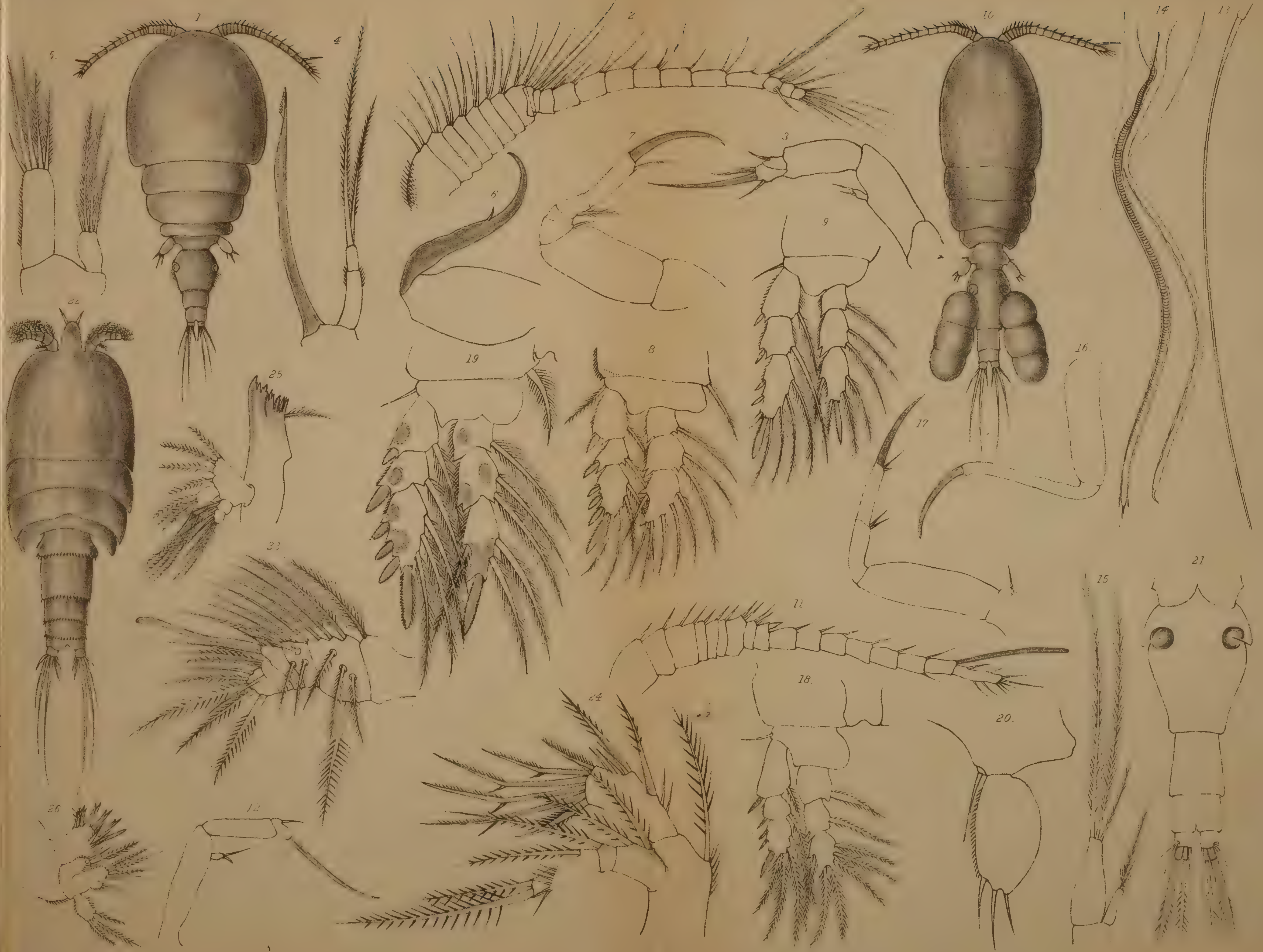


A. Scott, *del. ad. nat.*

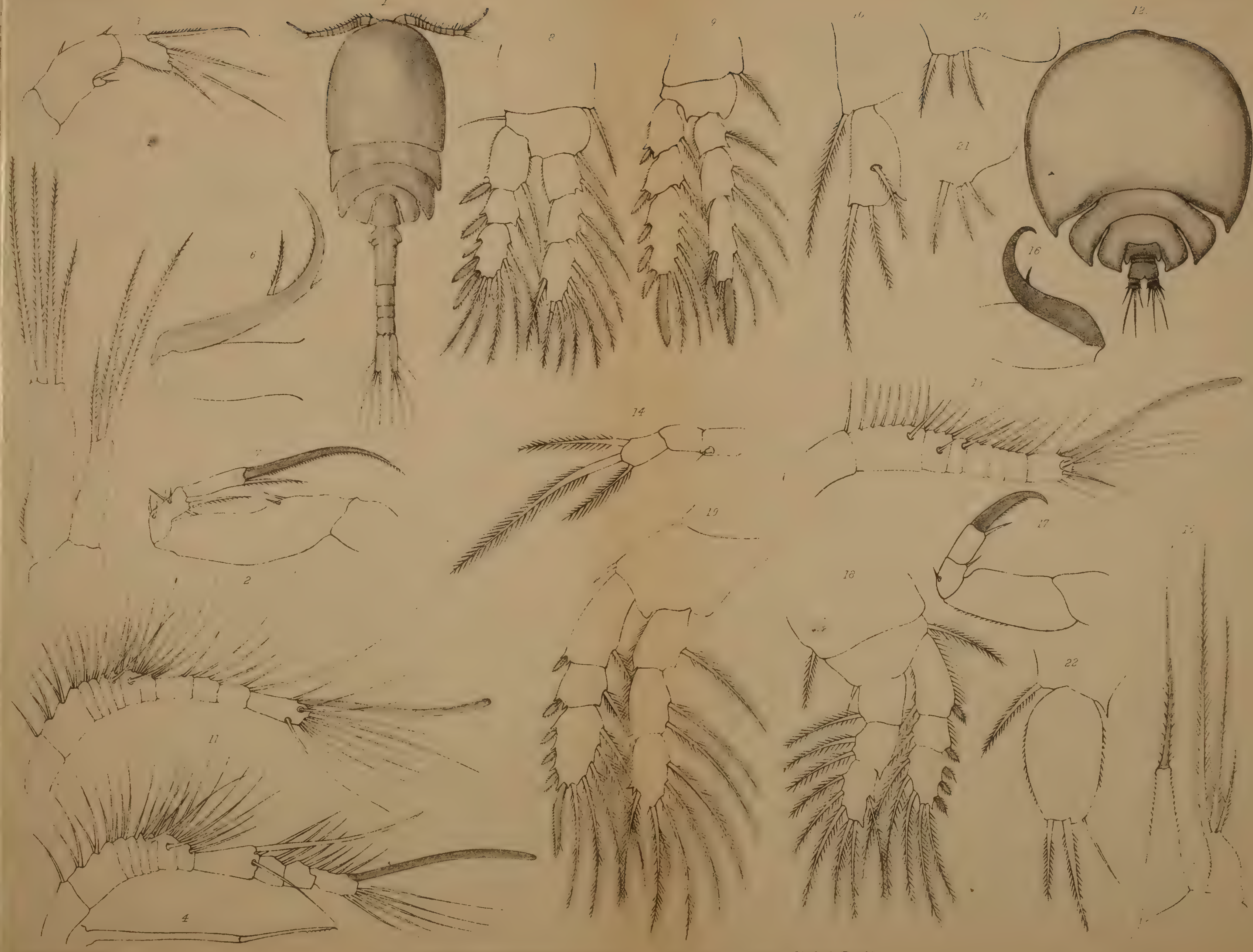
Figs. 1-19.—*Bradyidius armatus* (Brady). Fig. 20.—*Ætidius*, sp.



. Scott, *del. ad nat.*

Figs. 1-9.—(?) *Ascomyzon simulans*, n. sp.   Figs. 10-21.—*Scottocheres elongatus* (T. and A. Scott).   Figs. 22-26.—*Pseudotachidius coronatus*, n. g. et. sp.

PLATE XIV.

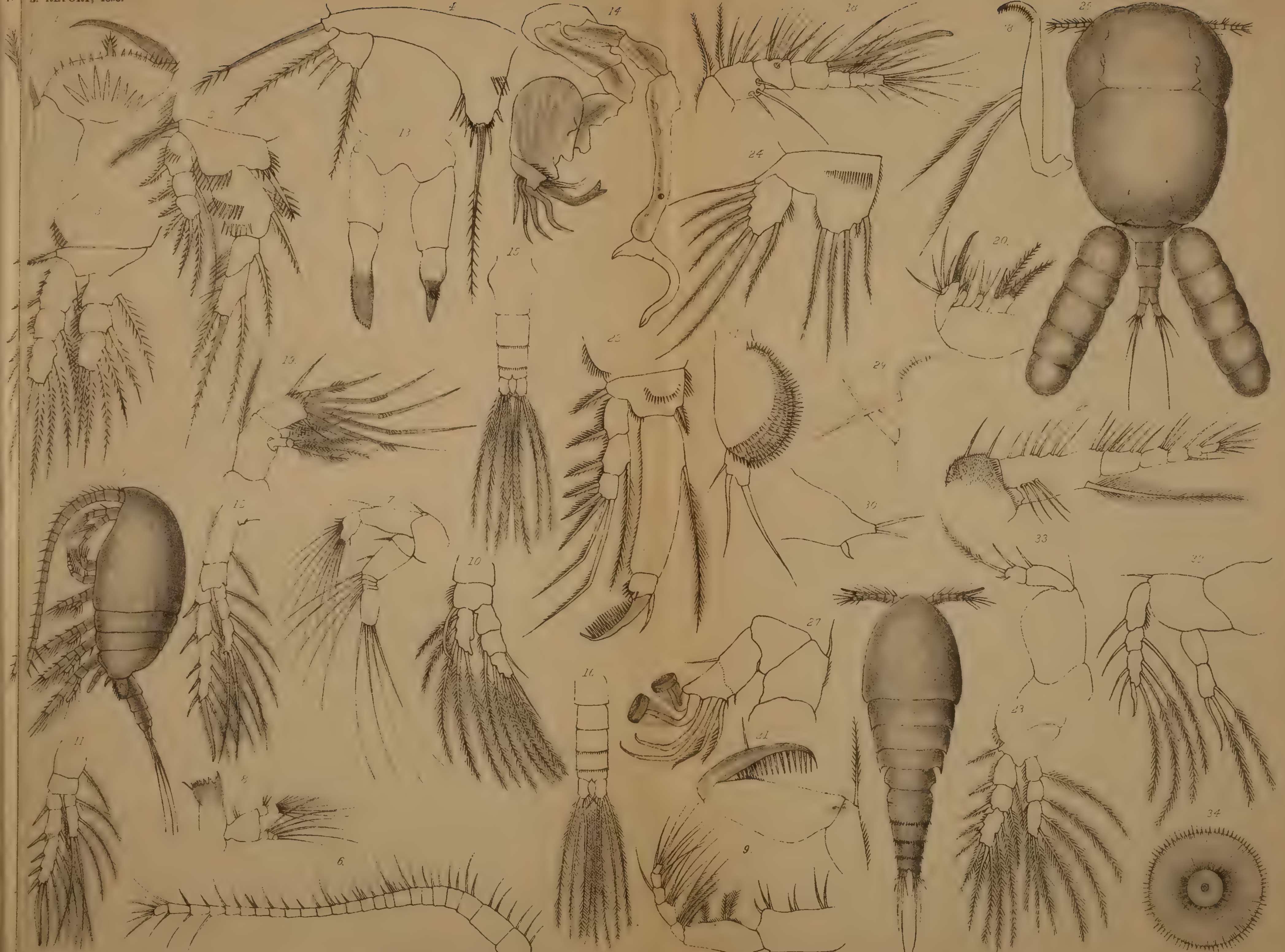


A. Scott, *del. ad nat.*

Fig. 1-11.—*Neopontius angularis*, gen. et. sp. nov.

Figs. 12-22.—*Artotrogus orbicularis* (Boeck).

PLATE XV.



A. Scott, *del. ad nat.* Figs. 1-4.—*Pseudotachidius coronatus*, g. and sp n. Figs. 5-16.—*Stephos fultoni* (T. and A. Scott) Figs. 17-24.—*Dactylopus pectinatus* (T. and A. Scott). Figs. 25-34.—*Eurynotus insolens* (T. and A. Scott).

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